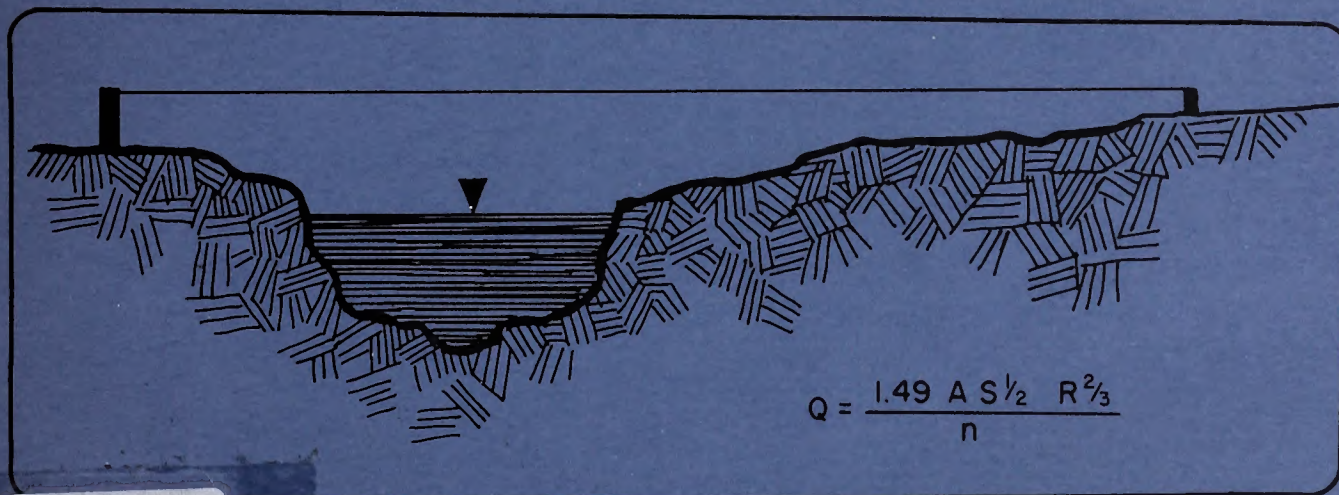




# INSTREAM Flow Guidelines



**June • 1979**

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Bureau of Land Management

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## PREFACE

To meet the requirements of court-ordered water adjudication and to quantify instream flow needs for fisheries, wildlife, recreation, water resources, livestock, and other resources on public lands, a system of instream flow needs assessment was urgently needed by the Bureau of Land Management.

The BLM established in August 1977 an interdisciplinary task force with the objective of developing an instream flow assessment system to be used by all BLM field offices.

The guidelines were developed by the Instream Flow Task Force after consultation with the Cooperative Instream Flow Service Group, Office of Biological Services, Fish and Wildlife Service, Fort Collins, Colorado, and the U.S. Forest Service, Regions 2 and 4.

Task Force members were as follows:

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The original guidelines were issued to the field under a Washington Office Instruction Memorandum (WO-78-534) dated September 22, 1978. Since then, minor errors were found and corrected, and some sections have been updated as needed.

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# INSTREAM FLOW GUIDELINES

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## CHAPTER I. - INTRODUCTION

### A. Definition

An instream flow requirement is defined as the quantity of water needed to maintain the existing and planned in-place uses of water in or along a stream channel or other water body and to maintain the natural character of the aquatic system and its dependent systems. Instream uses include downstream water supply, water quality maintenance, groundwater recharge, livestock watering, recreation, and the preservation of fish and other wildlife populations. The aquatic and riparian ecosystems and the physical features of the water body are the dependent natural systems. A stream's physical features include its channel, floodplain, and characteristic flow pattern. Standing water bodies include such features as lakes, ponds, marshes, bogs, wet meadows, and similar other wetlands.

### B. Purpose

This document provides field guidance in the application of acceptable methodologies currently in use or under development for the quantification of the instream flow requirements of the Bureau of Land Management.

In no way should this document be construed to be a comprehensive manual on water rights. Water rights subjects are addressed only to the extent that they pertain to instream flow.

The reasons for quantifying instream flow requirements may include one or more of the following:

- A general court adjudication of all water rights on a drainage basin initiated under the McCarran Water Rights Suits Act (66 Stat. 560, 43 U.S.C. 666) on which the United States has been joined as a party defendant.
- A State or Federal administrative water rights proceeding conducted for the purpose of river basin planning.
- Support of the land use planning system used by the Bureau of Land Management.
- Development of the management plan for a wild and scenic river.
- Support for a cooperative agreement with, or protest to, an upstream reservoir operator or divertor.

### C. Authority

Primary or general authority for BLM maintenance of instream flows:

Taylor Grazing Act, 43 U.S.C. 315.  
O & C Act, 43 U.S.C. 1181.  
Act of March 29, 1944, 16 U.S.C. 583.  
Wilderness Act, as referenced by Section 603 of the Federal  
Land Policy and Management Act of 1976.  
Classification and Multiple-Use Act of 1964 (expired), 78  
Stat. 986.  
Endangered Species Act, 16 U.S.C. 1531 - 1543.  
Wild and Scenic Rivers Act, 16 U.S.C. 1271, et. seq.  
National Environmental Policy Act of 1969, 42 U.S.C. 4321,  
et seq.  
Sikes Act, 43 U.S.C. 670.  
Federal Land Policy and Management Act of 1976, P.L. 94-579;  
90 Stat. 2743.

Secondary authority applicable to limited situations:

Fish and Wildlife Coordination Act, 43 U.S.C. 661-666c.  
Watershed Protection and Flood Prevention Act, 16 U.S.C.  
1001.  
Water Resources Planning Act, 42 U.S.C. 1962, et seq.  
Water Bank Act, 43 U.S.C. 1301, et seq.  
Coastal Zone Management Act of 1972, 16 U.S.C. 1451-1464.  
Safe Drinking Water Act, 42 U.S.C. 300f, et seq.  
Clean Water Act of 1977, P.L. 95-217; 91 Stat. 1566.

NOTE: See Appendix 1 for complete citations and applicable  
statutory language or summary comments.

## CHAPTER II. - STRATEGY FOR OBTAINING INSTREAM FLOW RIGHTS

The Bureau's most urgent need for quantifying instream flow requirements exists due to ongoing or expected water rights adjudications. Although the information obtained from the application of the recommended methodologies is useful to the land manager for many other reasons such as those cited in the introduction, it becomes essential in the context of a general adjudication of water rights. In this context the Bureau's objective is the legal protection of those uses of water identified as being necessary for the accomplishment of Bureau programs so that the identified uses may be continued or made possible in the future. Upon the termination of a general adjudication, no person (or Government agency!) within the drainage basin which defines the geographic limits of the lawsuit will have any legal right to the use of water except as stated in the final court decree.

To avoid being unable to state and quantify all Bureau claims to water in those regions which may become involved in McCarran Act adjudication within the time allowed by the presiding judge, it is absolutely necessary that all responsible Bureau offices be able to testify as to all uses and reservations of water within their areas of responsibility, whether the uses are actually occurring or are contemplated within the foreseeable future. Generally speaking, information on Bureau water rights, especially concerning instream flows, is not presently available in a form sufficiently well documented to withstand challenge in court. All Bureau managers who are responsible for programs involving the use of water in any manner whatsoever are advised to initiate studies and surveys of the types recommended by this guidebook. They will then be able to quantify and legally protect the water rights required for successful accomplishment of their resource management programs.

In conducting the studies and surveys, several legal concepts and institutional constraints need to be kept in mind:

A. Rights to the use of water are property rights which must be protected by any court, Federal or State, which has jurisdiction.

B. The water rights of the United States fall under four basic categories:

### 1. Public Lands

Property of the United States which has been acquired by treaty, conquest, or purchase and has not passed into private or State ownership is in this category. It is subject to disposition by Act of Congress or by private appropriation in accordance with statutory procedure.

## 2. Reserved Rights

Wherever a reservation of land for benefit of the Federal Government has been made from the public lands, it includes an implied right to the use of sufficient water to accomplish the purposes of the reservation. The reserved water rights are limited to the amounts of water needed for the purposes contemplated by the officials who established the reservation at the time it was established. If additional purposes for a reservation are authorized at a later date, the water rights for those purposes are created at that time. The waters which are subject to reserved rights of the United States are not part of the public lands even if the uses have not been initiated and are therefore not subject to further appropriation.

## 3. Appropriated Rights and Rights Acquired by Historical Use

Wherever the Federal Government has put water to use pursuant to statutory authority enacted under the powers granted by the United States Constitution, a property right is created which is of the same character as a privately owned water right. The United States acts as appropriator just as does the individual who lawfully appropriates water from the public lands and creates a private water right. A long standing pattern of historical use, such as for livestock watering on the public lands, can provide evidence of an appropriation on behalf of the public.

## 4. Riparian Rights

In those States which recognize the common law of riparian water rights, the United States, as the owner of land located along a stream or body of water, has the same rights as any other private riparian landowner subject to any appropriations in which the Desert Land Act is operative.

C. The Desert Land Act of 1877, as amended (43 U.S.C. 321-339), provides that "all surplus water . . . upon the public lands . . . shall remain and be held free for the appropriation and use of the public . . . subject to existing rights." Because this law applies only to the States of Arizona, California, Colorado, Idaho, Montana, New Mexico, Nevada, North Dakota, Oregon, South Dakota, Utah, Washington, and Wyoming, these States must recognize the law of prior appropriation, at least insofar as appropriations from the public lands are concerned. By enactment of the Desert Land Act, Congress severed title to waters on public lands from title to the public lands and recognized the jurisdiction of the named States to establish rules for the appropriation and use of water on the public lands of the United States within their boundaries.

D. Agencies of the Federal Government are not bound by State law definitions of beneficial use for establishing water rights because of the Supremacy Clause and the Necessary and Proper Clause of the United States Constitution. Wherever a Federal agency is directed to execute

a congressionally authorized activity which requires an appropriation of water from the public lands, and the water is subsequently put to use, an appropriate water right is established.

E. Except for McCarran Act general adjudications before a court of competent jurisdiction, the Federal agencies are not required to quantify or give public notice of their appropriations or reservations of water from the public lands. However, as a matter of comity, and in order to assist the State's water rights administration efforts, it is desirable that the Federal agencies make their water rights a matter of public record.

F. An appropriation or reservation of an instream flow can be established by the identification of the need for the flow pursuant to proper authority such that the required flow is no longer considered part of the public lands subject to further appropriation. In order to claim a water right on behalf of the Federal Government, the claiming Federal agency must be able to point to a document which establishes the priority date. For the Bureau of Land Management, these documents can be Executive Orders, Secretarial Orders, Federal Register publications, or formal resource use designations and land use planning documents.

G. For proof of a water right in a court proceeding, all documents must be introduced by oral testimony by knowledgeable officials. If firsthand personal knowledge cannot be presented as to specific facts, the authenticity of the supporting documents must be proved. It is absolutely imperative that accurate written documents be prepared for all data collection concerning instream flows. Chains of custody for all data, instructions given to field crews, lines of supervisory authority, and descriptions of work practices must be very well documented in order to substitute for firsthand oral testimony.

While conducting instream resource inventories, the flow requirements for the following types of uses should be considered:

1. Sport and commercial fisheries.
2. Protection of anadromous and nongame fish species.
3. Preservation of aquatic animals.
4. Protection of migratory bird habitat.
5. Maintenance of desirable vegetative growth and associated ecological systems.
6. Propagation of dependent terrestrial wildlife.
7. Watering of livestock grazing on public lands.

8. Preservation of aesthetic and scenic values.
9. Provision of public recreation.
10. Rights of public access and navigation.
11. Watershed management objectives.
12. Maintenance of water quality for domestic and municipal water supply and instream needs.
13. Fire prevention and suppression.
14. Reserved rights for appurtenant reservations.
15. Maintenance of stream channel integrity.
16. Maintenance of groundwater recharge.

This list may not be all inclusive; any use which requires that an instream flow be maintained should not be ignored.

After the needs for instream flows are identified, the statutory authorities should be reviewed to determine which acts apply to the various identified needs. In many situations, two or more of the acts may apply. In preparing legal claims for the preservation of instream flows, the full range of applicable statutory authorities should be cited. This procedure will help ensure that the earliest possible priority date is given to each of the Bureau's claims. Counsel from the Office of the Solicitor is advised during this phase of the process. The apparent lack of statutory authority should not deter the identification of instream flow needs; one or another of the acts can probably be construed to apply to any situation through creative argument.

Each BLM-administered reservation from the public lands which is appurtenant to a stream or otherwise involves a requirement for instream flow must be identified and quantified. The authority for each reservation will be stated in the documents which established its existence. Counsel from the Office of the Solicitor is also advised during the examination of a reservation involving a right to the use of water so that the intended purposes for the reservation can be fully described.

Some of the types of reservations which may concern instream flows are:

1. Public water reserves.
2. Stock driveways.

3. Wild and scenic rivers.
4. Protective withdrawals.
5. Government administrative sites.
6. Recreation sites.
7. Mineral activities.
8. Power site reservations.\*
9. Reclamation withdrawals.\*
10. Wildlife refuges.\*
11. Navigation.\*

After the identification and quantification of instream flow needs, all established uses should be put on record with the appropriate State agency which administers water rights. In the event that some of the Bureau's water rights claims are rejected by the States' administrative agency, the Bureau office presenting the claims should provide a written protest which fully discusses any disagreements. This type of letter protest should be written with the assistance of counsel with copies being provided to interested divisions of the Washington Office.

Whenever the Bureau's claims are not recognized by the State agency, the responsible State Director should prepare a recommendation for the initiation of litigation designed to compel recognition of the Federal water rights. For those Bureau offices which are already involved in McCarran Act adjudications, counsel should be sought from the Department of Justice trial attorney and the participating personnel in the Office of the Solicitor.

If the Bureau fails to assert its water rights claims in an aggressive manner, especially those claims which have been rejected by State authorities, the equitable doctrines of laches and estoppel may

---

\*Many reservations from the public lands such as national parks and monuments, reclamation projects, national forests, military reservations, and Indian reservations, including some of the above listed types, are the responsibility of agencies other than the BLM. However, if it appears that another agency is not actively managing the reserved lands, the BLM should either assert the appurtenant water rights or else ensure that the agency with primary jurisdiction makes its own claims.

defeat the Bureau's claims at a future date. It is essential that a rejection by a State administrative agency be protested in order to preserve the claims for judicial determination.

NOTE: This discussion on the strategy for obtaining instream flow rights is provided for background information only. The entire subject of the Bureau's water rights is presently under review in the Office of the Solicitor which plans to issue a formal opinion.

### CHAPTER III. - INSTREAM FLOW NEEDS IDENTIFICATION

The process of quantifying the instream flows required to support the Bureau's various resource management programs could involve either (1) a broad reconnaissance to obtain information on which to base resource allocation decisions, or (2) a site-specific study which constitutes an activity plan based upon a Resource Management Plan Step 3 management decision.

This guidebook describes methodologies suitable for both types of requirements. Activity planning requires the use of a more technically precise and legally defensible method.

The flow quantification process involves a site-specific study of the present situation, followed by a scientific assessment of flows needed to satisfy selected resource criteria. The study must begin with identification of the purposes for which instream flows are needed, followed by a decision as to where the flows are needed and, finally, determination of the quantities of water, by season, necessary to satisfy these identified purposes.

The resources or natural systems dependent upon instream flows in a particular stream could include any or all of the following:

- support of fish and wildlife populations,
- terrestrial and aquatic habitat,
- maintenance of water quality and channel integrity,
- recreational activities,
- aesthetics,
- livestock water (including water to support wild horse and burro populations),
- maintenance of aquatic ecosystems, and
- groundwater recharge

#### A. Interdisciplinary Team

It should be obvious that the instream flow quantification process requires an interdisciplinary effort from the beginning of the study. A study team should be selected to adequately address each of the individual purposes as well as the necessary hydrology-hydraulics and institutional framework. Depending upon outside interest in the study, the team may include representatives of other State and Federal agencies.

#### B. Preparatory Steps

The team should begin the study with the following preparatory work:

1. The study team, with direction from the responsible line manager, should first establish some background or "ground rules" for the study. His guidance should consist of:

- a. A specific statement of the scope, purpose, and goals of the study.
- b. The administrative, financial, legal, and time constraints. A discussion of legal constraints is contained in Chapter II.
- c. Description of the desired end product which fulfills the study purpose (adjudication suit, activity plan, etc.).
- d. The responsibility of each team member in accomplishing the stated goals.

2. Assemble working maps and photos covering the subject stream reaches to their headwaters. The U.S. Geological Survey 7-1/2 minute scale quadrangle maps (approximately 2.6" = 1 mile) will make an excellent working base, although the 15-minute quadrangles are adequate. Orthophoto quad maps would be an excellent base where they are available. Delineate on the map(s) the exact reach or reaches of concern to each discipline. Identify land ownership patterns (BLM, other Federal, State, and private) which might affect maintenance of instream flows. Divide the stream or reach into subreaches at natural or manmade points of change such as at the confluence of significant tributaries, change in gradient, and points of major diversion. A set of aerial photos, particularly low level, will prove useful later on and may be helpful in selecting the subreaches.

3. Identify all existing uses throughout and above the reaches in question on the working map. This identification should include diversions and onstream storage facilities. If possible, indicate the amount diverted or stored, timing and purpose of uses, timing of releases, and all other data affecting the natural availability and variability of flows.

4. Each discipline should identify particular reaches, sections, or features of the stream(s) that are believed to be critical or limiting for various instream uses. This could include spawning reaches, float boat passage, or livestock watering points. Identify these critical uses by season. It may prove helpful to summarize the existing use data versus instream needs for each subreach in a chart form, such as Figure 1.

5. Assemble all other pertinent resource data which are available, including streamflow and water quality records, physical and biological stream surveys, lake and reservoir surveys, riparian habitat inventory, recreational use surveys, and livestock use data. This effort is essential in determining the amount and kinds of additional field data required for the study. Much of this information may have already been collected for land use planning purposes. Plot gaging station locations and reference numbers on the working map.

Having assembled the necessary background information, the team should then plan the field quantification studies. This task is accomplished by first developing and assembling available methodologies, determining their limitations and applicability, and finally choosing the appropriate methodology.

"SAMPLE"

Figure 1. Summary of existing uses and needs by month.<sup>1/</sup>

Stream Name: \_\_\_\_\_ Subreach: \_\_\_\_\_

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Average Monthly Discharge (cfs) <sup>2/</sup>	15	14	13	13	14	20	25	45	70	55	40	25
Existing Uses (cfs)												
1. XYZ Irrigation Company	0	0	0	0	0	0	0	10	10	15	20	10
2. Town of Podonk	3	3	3	3	3	3	5	6	10	15	15	9
3. Livestock	.3	0	0	0	0	0	0	.3	.3	.3	.3	.3
4.												
5.												
6.												
Instream Needs <sup>3/</sup>												
1. Recreational Floating												
2. Fisheries												
3. Riparian Vegetation												
4. Groundwater Recharge												

(From Tew et al., 1977)

<sup>1/</sup> This figure is presented in Appendix 2 for field use.

<sup>2/</sup> From flow records if available.

<sup>3/</sup> Add quantities when determined.

## CHAPTER IV. - RESOURCES CRITERIA SELECTION

### A. Fisheries and Aquatic Habitat

Present sections of the BLM Manual list necessary procedures to inventory fisheries and aquatic habitat (BLM Manual Section 6670). In addition, completed State and Federal agency stream surveys should be used as a data base.

The inventory and stream assessment work should be coordinated with State fisheries agencies and it is desirable to involve their personnel in the instream flow data collection. In lieu of BLM Manual guidelines, use established fisheries inventory procedures to collect data. Habitat requirements of aquatic animals in the stream under study will be the basis for development of instream flow requirements.

#### 1. Physical and Biological Stream Inventories

Stream inventories under present BLM Manual procedures or other approved inventory procedures will be the basis for criteria selected for instream flow procedures and analysis.

Stream inventories are essential in order to make knowledgeable site selection for detailed instream flow and habitat measurements. As part of the stream inventory it is necessary to have a quantitative inventory of the fish species and other aquatic organisms present in the stream section under study. The inventories form the information base of the aquatic species of interest. The information base is then used to evaluate the impacts caused by changes in stream hydraulics.

#### 2. Biological Criteria

Biological criteria of fish and aquatic species listed are related directly to streamflow and channel morphology, such as velocity, depth, water temperature, and stream substrate. Cover, a physical condition of the stream, is of major importance to the welfare of many fish species and is almost directly related to streamflow. Nearly all stream habitat recovery procedures identify available cover for fish.

The integrity of the aquatic ecosystem is an important consideration for instream flow maintenance. Unidentified flora and fauna may exist in the stream other than known fish and other aquatic species.

Aquatic species for which biological criteria should be developed are generally divided into five classes (Bovee, 1977):

a. Management Objective Species. These are sport and commercial fishes that are considered important and desirable by the public and are of importance to the objectives of the State and Federal management agencies.

b. Indicator Species. These are species with narrow habitat tolerances. They inhabit areas of streams and are particularly sensitive to changes in flow. It is assumed that if conditions are suitable for the indicator species, all other species will also have suitable habitat.

c. Threatened, Endangered, and Sensitive Species. These are species which are classified by Federal listing or identified officially by State fisheries agencies.

d. Important Nongame Species. Fish that are important for preservation of the ecosystem but not desirable as a sport fish.

e. Forage Species. This classification applies to those organisms occupying various positions in the food chain, including both forage fish and aquatic invertebrates.

Flow assessment methodologies in common use may address one or more criteria important in life history stages of aquatic animals. For example, spawning habitat and success are considered critical factors in maintenance of fish stocks; however, rearing habitat for fry and juveniles is equally important. Systems, such as the Multiple Transect-Incremental Flow Method, develop criteria for all life stages (Bovee and Cochnauer, 1977).

## B. Wildlife Habitat

The selection of the amount of water needed in an aquatic system to sustain viable populations of riverine and riparian dependent wildlife also requires inventory and assessment of the physical and biological components of the aquatic environment.

The inventory of the study area can be accomplished by using guidelines detailed in BLM Manual Sections 6602 and 6610. In addition to BLM Manual guidelines for inventory, the individual State or other Federal wildlife agency inventory data should be obtained for the study area. As with fisheries and aquatic surveys the work should be coordinated with the State wildlife agency to prevent duplication and to promote the highest degree of joint habitat inventory. In lieu of BLM manual inventory guidelines for some species of wildlife, use established professional inventory procedures to collect data.

The stream and riparian habitat inventory, together with a wildlife species inventory, form the basis for the criteria selected for instream flow analysis. After a wildlife species list is developed, the life history and habitat requirements for each species are used as a basis to evaluate the impacts caused by water depletion and/or fluctuation in the stream.

The biological criteria for riverine and associated wildlife found to be in the study area can be directly related to channel morphometry, such as velocity, depth, and stream and bank substrate. The associated riparian vegetation and riparian area take on extreme importance to riverine wildlife and the health of the population of animals is related directly to the condition of the riparian habitat. Research has shown that the structure of the riparian habitat must remain stable to assure continued use by riverine wildlife (Thomas et al., 1976).

Wildlife for which biological criteria should be developed are generally divided into six classes.

1. Management Objective Species

Game species that are considered important by the hunting and interested public and are of importance to the objectives of State and Federal management agencies.

2. Indicator Species

Animals that have narrow habitat tolerances. They generally inhabit areas of stream or riparian habitat which are particularly sensitive to changes in flow.

3. Threatened, Endangered, and Sensitive Species

These are species which are classified by Federal listing or identified officially by State wildlife agencies.

4. Important Nongame Species

Species of wildlife important in the food chain of many other wildlife species.

5. Wildlife Criteria

These must be developed for specific avian species, as well as reptiles and amphibians.

6. Aquatic Species

Specific criteria must be developed for these species by consulting best available authorities.

Flow assessment methodologies recommended by this task group may not address all the important criteria important in the life history of riverine wildlife. It will be incumbent on the wildlife biologist to relate various water stages or flows to the critical life history stages of wildlife. Some important considerations will be the times and duration of nesting of waterfowl and water oriented avian species; critical life stages of egg deposition and larvae movement of amphibian species; water

level fluctuation during the kit life of otter, muskrat, and beaver; and sufficient water for survival of all wildlife during critical dry periods. The criteria for all life stages of various wildlife species for the Multiple Transect-Flow increment method are being developed by the instream flow group of the Fish and Wildlife Service in Fort Collins, Colorado.

The wildlife values associated with the riverine and riparian habitat must not be omitted from consideration of proper instream flows. These areas receive considerably more use per unit than any other type of habitat. The vertebrates that reproduce in water and feed in water are, of course, confined to such habitat zones (Kelly et al., 1975; Bottorff, 1974; Wooding, 1973; Beidleman, 1948 and 1954.)

### C. Recreation and Aesthetics

#### 1. General Criteria for Recreation Uses

Often recreational and aesthetic instream flow needs are satisfied by claims for aquatic and riparian habitat. However, there are situations where specific claims will be necessary for recreation and aesthetics. Due to the many variations in existing use, potential use, and resource suitability, instream flow needs for recreational uses will have to be developed for each individual stream. For recreational uses the following steps should be accomplished to establish instream flow needs:

a. Identify the recreational uses that occur or are planned for each stream. The Unit Resource Analysis (URA) and Resource Management Plan (RMP) should contain this information. Data from the Recreation Information System (RIS) should also be used. When the URA and RMP are not adequate, or have not been completed, inventory data must be developed through the RIS.

b. Locate the most critical channel site for each identified recreational use. Determine the water depth needed for the desired user experience. Using one of the appropriate methodologies, determine the flow in cubic feet per second (cfs). Lastly, list the various activities in descending order with those having the highest instream flow needs listed first. When identifying the most critical channel site, keep in mind the major determining factor will be the configuration of the stream bottom or the "wetted perimeter." A very broad stream bed with many large rocks and gentle sloping banks may require substantial instream flow to accommodate such activity as float-boating, especially if large inflatable rafts are used. Typically streams are:

- (1) parabolic or U-shaped,
- (2) rectangular - flat bottom with vertical sides,
- (3) triangular or V-shaped, or

(4) trapezoidal or V-shaped with a flat bottom (Stalnaker and Arnette, 1976).

c. List for each identified recreational activity the annual visitation attributed to the activity. Show both visits (the number of individuals who benefit) and 12-hour visitor days (the amount of actual use). Show projected use figures in visits and visitor days. Identify any use capacities established for public safety, protection of the stream, and its environment and/or for increased visitor enjoyment. Identify how long the public has enjoyed each activity. Identify established commercial users (those who provide for a fee recreational services utilizing the stream). Provide a summary of the economic benefits sustained by continuation of such uses. Show what portion of the visitor use is attributed to the commercial service.

d. Identify the indirect economic benefits to the local communities, county, and State derived from continued recreational uses on the stream.

e. Identify the season for each recreational use. Some activities have a season established by regulation while others have a season determined by seasonal temperatures. In warmer geographic regions, some activity seasons may be yearlong. The season of recreational use will establish when instream flows must be maintained (see Figure 1, page 11).

f. Identify coordination requirements. Consider uses that are common to both BLM and other private, local, State and Federal agencies. Jointly develop a list of recreational activities both existing and planned for the same stream system. Document coordinated management criteria for each use on each stream including instream flow needs. As a result, you may wish to develop joint recreational activity management plans for individual streams.

g. Whenever possible, document your findings with photographs showing higher than optimum instream flows, optimum flows, and flows that are inadequate for identified activity uses. This is especially important for aesthetic uses. Continue to monitor seasonal effects of instream flow fluctuations through establishment of photo points and continued seasonal photography and/or photography at planned intervals on streams where flows are regulated by dams and diversions.

h. Using the data collected, analyze the recreational activities and their instream flow requirements. Determine the best recreational use, or more often combinations of uses. Since water requirements will differ considerably for each activity, it may not be possible to establish instream flow requirements that will favor all existing or potential uses. Develop or modify existing RMP recommendations from this analysis. Document the analytical process used to determine best recreational use recommendations. Based on this analysis and the RMP decision, develop the appropriate recreation activity management plan.

## 2. Instream Flow Requirements for Boating

Boating on rivers and streams must be considered in two major categories, white water boating and tranquil water boating. While some of the same boats and equipment may be used for both boating experiences, the instream flows required will be different due to the desired experience and streamflow characteristics.

a. Identify recreational boating activities by type of water craft used. Common craft by boating activity are shown in the following table:

Type of Craft	Used In	
	White Water	Tranquil Water
Canoeing	X	X
Rowing (Hard Hull)	X (McKenzie)	X
Sailing		X
Powered Boats	X	X
Air Boating		X
Rubber Raft	X	X
Kayaking	X	X
Sport-Yak	X	X

Water craft not listed in the table may be popular on certain streams. These should not be overlooked. Each type of boat or boating activity requires different water depths for flotation. When selecting the most critical channel site and establishing the flow requirements, allow for boat flotation requirements when loaded plus a minimum of 1 foot clearance over stream bottom, rocks, etc. Also, take into consideration side clearance. Large rubber rafts, for example, will require much more vertical and horizontal clearance than a canoe or kayak.

b. If possible, list separately visitor-use data by boating activity. This will help identify which boating activities are important or critical on your river or stream.

c. Identify if the boating season(s) is limited by reduced instream flows. Identify if it is possible to lengthen the season by manipulation of the instream flows. If so, explain how. Determine if the boating experience would be enhanced by seasonal high flows or flood flows to renew beaches and replenish firewood (driftwood) supplies.

d. When boats are used as a part of another water activity such as water skiing, fishing from a boat, or to provide fisherman access to otherwise inaccessible fishing waters, instream flows must be considered for both activities.

### 3. Fishing

Obviously, instream flows that enhance game fish habitat are of most benefit to recreational fishing. Streams that are able to maintain large game fish populations and produce rapid fish growth will be heavily used. Therefore, instream flow needs and nutrient levels that are optimum for production of game fish are also the optimum for recreational fishing. In general, if a stream is to be managed for recreational fishing, flow requirements should favor the fish species favored by the user. Applicable data collection called for under the general section above should be carried out to fully support instream flows and nutrient levels.

### 4. Water Contact Activities

Water contact activities include swimming, scuba diving, wading, tubing, and water skiing.

a. Swimming and wading usually occur at specific points along streams such as at favorite camping or picnic sites. For these uses, instream flows need to be sufficient only to fill the swimming hole and provide adequate circulation of water through the area to avoid stagnation and contamination. Suitable areas may be developed by the construction of large pools.

b. Water skiing and tubing require higher flows. Water skiing needs will be met by providing flows that are optimum for power boating on tranquil waters. Optimum flows for tubing will be largely a product of instream flow characteristics. Streams used for tubing must be free of snags and other debris including structures that can catch a tube and/or participant. Water velocities should be low enough that currents will not pull or plunge participants under the water surface or dash them against rocks.

c. A major factor in providing instream flows for contact activities is that they be at a level sufficient to maintain acceptable water quality standards. "These requirements are based on microbiological considerations, temperature, pH, clarity and chemical characteristics. They are more precise than the requirements for general recreational waters. If a body of water cannot meet these specialized requirements, it should not be recommended for a bathing or swimming area but may be designated for a recreational use that does not involve planned immersion of the body" (Water quality criteria 1972 report of the National Technical Advisory Committee). Individual State offices should review current Federal and State standards and comply with the standards that are more restrictive.

Fecal coliform levels are used as an indicator of water quality. The fecal coliform content is determined by either multiple-tube fermentation or membrane filter techniques. The National Technical Advisory Subcommittee for research and aesthetics has recommended standards. Check EPA suggested criteria and individual State regulations for water quality standards.

## 5. Wilderness

When determining instream flows in wilderness, any alteration of natural streamflow must be considered. Controlled or altered streams are no longer in their natural condition. This alone is not likely to disqualify an area for wilderness designation, but once an area is designated or recommended for wilderness, streamflows should not usually be manipulated even if such manipulation would enhance other resource values including recreation. An exception, however, would be to take actions that would restore natural or near natural flows to these streams. During the planning of upstream improvements or diversions, the resulting effect on recommended or designated wilderness must be considered. To determine what flows are needed, review historical and hydrological records. One must keep in mind actions involving motorized equipment are not permitted inside the wilderness boundary but may be used upstream from a boundary.

## 6. Wild and Scenic Rivers

The Wild and Scenic Rivers Act is somewhat specific in its requirements for instream flows.

a. Wild River Areas. The Wild and Scenic Rivers Act in Section 2b(1) states that wild river areas are "Those rivers or sections of rivers that are free of impoundments and generally inaccessible, except by trail, with watersheds or shorelines essentially primitive and waters unpolluted."

River sections with upstream impoundments have been recommended for wild river designations in spite of the statement in the Act that they shall be preserved in "free-flowing condition" [Sec. 1(b)]. This indicates that if impoundments and diversions are not within the designated river section they may be acceptable. It is clear, however, that such changes in river flows must not adversely affect the immediate environments. ". . . immediate environments shall be protected for the benefit and enjoyment of present and future generations" [Sec. 1(b), Sec. 7(c) and (b)].

b. Scenic Rivers. Designated scenic rivers are "Those rivers or sections of rivers that are free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads" [Sec. 2b(2)]. (See discussion under Wild Rivers above).

c. Recreational Rivers. Designated recreational rivers are "those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines and that may have undergone some impoundment or diversion in the past" [Sec. 2b(3)].

d. Water Quality. While the Wild Rivers Act states that designated rivers should be free of pollutants [Sec. 2b(1), Sec. 9(a), Sec. 12(c)], there are natural pollutants in all rivers originating from wildlife and natural conditions. Water quality, therefore, should be maintained at or above what it was at the time of designation [Sec. 1(b)].

e. Instream Flow Administration of Wild and Scenic Rivers. Land management agencies are specifically required to administer those areas included in the National System of Wild and Scenic Rivers in such a manner as to protect and enhance those values that caused them to be included in the system. Aesthetic and public enjoyment considerations are specifically mentioned. Instream flows must, therefore, be maintained for recreational uses, fish and wildlife uses, scenic enjoyment, and riparian habitat maintenance [Sec. 10(a)].

## 7. Aesthetics

Aesthetic considerations must be applied as part of all recreational activities. It is a part of every recreational experience. Some recreational activities such as driving for pleasure are almost wholly dependent upon aesthetic values. We are concerned about aesthetic values associated with sight, sound, smell, and touch; the visual quality is the most significant of these values. (Aesthetics associated with touch are covered in the section under water contact activities.)

a. Recreational. Activities to be directly considered in determining instream flows for aesthetics include boating, fishing, and water contact activities. All other recreational activities are usually enhanced by the presence of running water. These include such things as sightseeing scenery, sightseeing zoological, sightseeing botanical, ORV, rockhounding, camping, picnicking, etc.

b. Visual. BLM Manual Section 8400, Visual Resources Management, should be applied in determination of visual sensitivity levels and assigning visual resource management classes. (Refer to applicable URA). Wilderness areas and wild, scenic, and recreational river segments should be considered as special areas in Class I. This class provides for natural ecological changes only. Instream flow requirements in Class II areas should be maintained to avoid changes in any of the basic elements (form, line, color, or texture) that will be evident in the characteristic landscape. For example, low flows that expose the stream profile also alter the form or the shape of the stream. Texture is introduced into the landscape created by the contact of riparian vegetation with the exposed stream bed. This texture may be smooth, as in the case of muddy stream bottoms, or rough, composed of large rocks or cobbles. New color is introduced into the landscape by the exposed stream bed. In Class III areas, instream flow should be maintained so that changes remain subordinate to the visual strength of the existing landscape character. In Class IV areas, instream flows should be

maintained so changes may be subordinate to the original composition and landscape character but may reflect what could be natural occurrence within the landscape. Class V areas are those where instream flows may need to be re-established to bring a stream back into character with the surrounding countryside. Once restoration is established, it should be maintained in one of the above classes. Restoration may include the riparian habitat, visual characteristics, etc., through rehabilitation or enhancement. (See BLM Manual Section 8400.)

There are other considerations in instream flow requirements. The riparian zone and the water itself attract wildlife which adds an aesthetic dimension to the visual scene. Instream flow needs for the maintenance of these plants and animals are also important to maintaining aesthetic qualities. Shade and natural screening are a product of the riparian zone. These qualities enhance public visitation to streamside areas for recreational pursuits as well as add interest to the visual landscape character. Visual pollutants, on the other hand, detract from the recreation experience.

c. Sound. Sound is an important aesthetic value associated with water. Instream flows should be maintained in areas of high visitation for the purpose of producing the sounds of running water such as in the locations of falling water, splashing water, or just the gentle trickling sounds of brooks and small streams. Sounds of wildlife attracted by maintaining instream flows and maintained riparian zones enhance public visitation.

d. Smell. Chemical smells or smells produced by organic pollution are adverse to maintaining aesthetic qualities for recreational uses. Bad smells are usually a product of poor water quality which can sometimes be partly resolved by maintaining specific instream flows.

#### D. Water Resources

Hydrologists should be concerned with the following resource variables in selecting hydrologic criteria for quantifying instream flow needs:

##### 1. Quality of Water (QW)

Such QW variables as suspended sediment, turbidity, dissolved oxygen, fecal coliform, pH, temperature, dissolved solids, bedload movement, and important chemical constituents should be considered. Criteria levels then should be selected based upon other resource needs (fisheries, recreation, etc.) and based on local, State, and Federal water quality standards. Some water quality variables are flow-dependent and can be predicted for various flow levels.

## 2. Channel Hydraulics

The sediment-carrying capacity of the stream for bedload and suspended load, including organic debris, should be considered when setting hydrologic criteria. As an example, streamflow should not go below the level that will allow spawning gravels to become inundated with silt. On the other hand, flows should not exceed a level that will create a channel disequilibrium condition by moving otherwise stable bottom materials, dislodging organic debris, or scouring channel sides and thereby upsetting the natural pool-riffle ratio of the stream.

## 3. Water Table Elevation

Criteria should be set that will maintain the existing riparian vegetation. Significant drops or prolonged rises in water table elevation are detrimental to riparian and wetland vegetation growth and maintenance. The presence of any rare or endangered plants in the riparian zone should be noted and taken into account.

## 4. Groundwater Recharge

Criteria should be developed that relate to the maintenance of a favorable groundwater recharge regime. Significant prolonged dewatering of a stream and associated drops in the riparian water table elevation may result in decreased groundwater recharge. Since groundwater discharge directly supports stream baseflows, maintenance of a suitable groundwater recharge regime will favor late season streamflows.

## E. Livestock Management

Maintaining a stream source for livestock water including wild horses and burros will generally be a desired objective on BLM lands. In cases where instream flow needs will be quantified for other resources such as fishery or recreation, this quantification will normally take care of livestock use.

The team must consider having water available during the entire grazing season (per applicable Allotment Management Plans), and the water must be of suitable quality for livestock consumption and in sufficient depth to permit the animals to drink. Selection of a minimum depth criteria would depend upon the geometry of the channel, the availability of pools, etc. It will ultimately be a judgmental decision. The hydrologist can provide criteria for maintenance of suitable quality. The limiting parameter most often will be total dissolved solids. A total dissolved solids/discharge relationship can be established for the study stream from existing records or a well planned reconnaissance study of about one year's duration. Generally, some information exists in the area to indicate whether a potential problem exists.

## F. Criteria Levels and Flow Alternatives

Through one of the quantification methods discussed in Chapter V, resource criteria are quantitatively related to discharge or water level. It is incumbent upon the resource specialist to select a reasonable, defensible criterion level from which the flow will be determined. The choice of a criterion level may not be an easy one, and in all cases it must be completely supportable. The criteria levels chosen must relate to one or more of the following: (1) a legal or policy mandate; (2) an established precedent, such as the published scientific literature; or (3) sound professional judgment.

An example of a legal mandate would be a state water quality standard. An established precedent might be recommended flow velocities for spawning channels as published in the fisheries biology literature.

The specialist will usually have to choose between an optimum criteria level and something that is less than optimum in terms of resource value. The specialist should try to define a threshold or marginal level for each criterion, below which resource values would be unacceptable, and above which resource values would be acceptable or preferred. For example, for a wildlife habitat the threshold level would relate to a survival or a maintenance situation. A maximum threshold would also exist for some criteria where resource values begin to decline above the maximum threshold level. The criteria levels chosen should relate back to Resource Management Plans and other subsequent land management decisions that establish relative values for the different resources concerned. The choice of criteria levels should be documented, showing the rationale for the decision, explaining the associated resource values, and discussing the resource values that would either decrease or increase from existing or natural values under those criteria levels. This documentation would then become part of the rationale accompanying the flow recommendation (See Chapter VI).

## CHAPTER V. - METHODOLOGIES FOR INSTREAM FLOW QUANTIFICATION

Numerous approaches to flow quantification are being used or experimented with at the present time. These approaches present many variations of a few distinct methods that have been developed by State fish and game agencies, Forest Service, Fish and Wildlife Service, and others. Three flow quantification methodologies were selected for application by BLM. They represent progressive levels of effort from a simple analysis of existing streamflow records to a multiple transect-flow increment method requiring considerable field information. As the reader might suspect, the higher degree of sophistication improves reliability, defensibility, and scope of application, while requiring more time and specialized expertise. The study comparing four methodologies (Prewitt and Carlson, 1977) on the Yampa River may be helpful in estimating comparative costs.

Prerequisite to each of the three methods, however, is an analysis of available hydrologic data.

### A. Analysis of Hydrologic Records

Prior to selection of an appropriate instream flow quantification methodology, analyses of hydrologic data are necessary. Flow characteristics of the stream may be the limiting factors which control all other stream qualities.

Analyses of water data require hydrologic expertise to assure that proper consideration is given to the hydrologic properties of the stream. Once this is accomplished, the information can then be related to the timing and sequence of life cycles of fish and other aquatic organisms, to wildlife and riparian habitat needs, to the type and location of recreational uses, and to the aesthetic considerations involved. The kind and amount of existing data will determine what kinds of analyses and correlations can be made. The prime objective of the records analysis is simply to develop basic information on streamflow and water quality in order to obtain an understanding of seasonal and annual variability. Data summaries of average monthly flows, average annual flows, low flow characteristics, and in some cases, average daily flows, are necessary. It may also be necessary to compute a set of natural flows for the stream in question, particularly if the watershed has been substantially altered by man's activities. Similar statistical parameters should be developed for various water quality variables, if the data are available.

A flow duration curve is a cumulative frequency curve of mean daily discharges and portrays the relative duration of various flow rates (Linsley et al., 1949). A flow duration curve is highly dependent on the observation period used in the analysis; mean daily data will yield a much steeper curve (see Figure 2) than annual data, and this fact must be kept in mind when analyzing the duration curve (Linsley et al., 1949). The use of daily flow records is recommended in flow duration analysis. If daily flows are not available, mean monthly flows should be used.

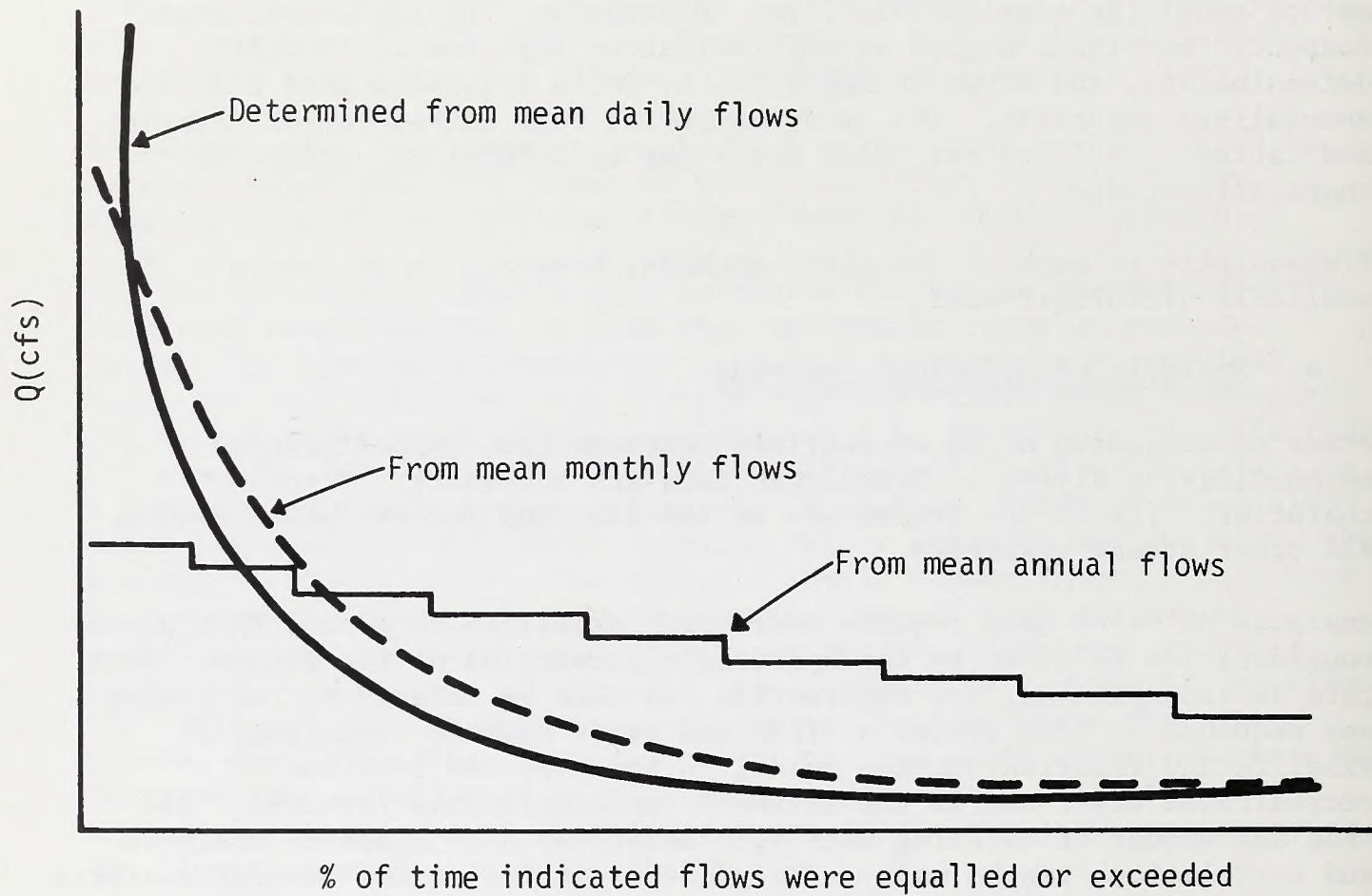


Figure 2. Flow duration curves comparing daily, monthly, and annual data.

Occasionally, hydrologic data can be extrapolated from a reference station to critical channel sites having similar hydrologic response characteristics for which there are no data. However, such analyses require considerable amounts of data. Except for the major river systems, and on river basin planning levels, such data are not available. Even on major river systems, long reaches may be lacking the detailed information necessary for intensive data interpretation. Very few drainage basins subject to public land administration have an adequate data network. Thus, it may be necessary for the hydrologist to synthesize flow data. There are four major approaches to synthesizing. These are: (1) Channel Geometry Methods; (2) Mathematical Watershed Modeling; (3) Precipitation-Runoff Relationships; and (4) Basin Correlations.

Thus, through actual and synthetic data analysis, seasonal variation of flows could be regionalized and extrapolated to many stream reaches having similar hydrologic characteristics.

#### B. Reconnaissance Level Method

For this level of survey, fixed-percentage methodologies are usually adopted for application. They primarily involve the selection of some fixed amount of discharge based on historic flow records. If only a rapid records analysis can be made due to time and manpower constraints, the method suggested for consideration in developing a reconnaissance level survey is the "Montana Method," developed by Donald L. Tennant (Tennant, 1975). This is a quick, easy methodology for determining flows to protect the aquatic resources on a broad scale, i.e., regional planning. If the study team has the time and capabilities for extensive field investigations, then it is recommended that one of the more sophisticated methods, discussed later, be used.

The method applies well in both warm water and cold water streams. It is based on average annual flow. With this method, analysis is accomplished using existing water resources data.

The method uses a seasonal percentage of natural average annual flow to protect the aquatic resource. The method assumes that the condition of the aquatic habitat is quite similar on most streams carrying about the same portion of the average annual flow. Basically, 10 percent of the average annual flow is considered a minimum instantaneous flow to sustain short-term survival habitat for most aquatic life forms. A flow of 30 percent is considered essential to sustain good survival habitat. Flows of 60 percent or more should provide excellent to outstanding habitat for most aquatic life forms.

The method can be applied to many stream segments quickly by referring to Table 1. Field work is not necessary in the use of this method if adequate surface water records are available (U.S. Geological Survey or other sources). These records are used in order to determine the average annual flow.

TABLE 1

Instream Flow Regimes for Fish, Wildlife, Recreation, and  
Related Environmental Resources 1/

Narrative Description of Flows	Fisheries Classification	Recommended Base Flow Regimes	
		Oct. - March	April - Sept.
Flushing or Maximum	--		200% average flow
Optimum Range	--		60-100% average flow
Outstanding	I	40%	60%
Excellent	II	30%	50%
Good	III	20%	40%
Fair or Degrading	IV	10%	30%
Poor or Minimum	--	10%	10%
Severe Degradation	--		10% average flow to zero flow

1/ After Tennant, 1975.

If average annual flow records (from actual stream measurements) are not available, which may be the usual situation on public lands, determinations by other methods, e.g., channel geometry methods, synthesized hydrograph, etc., may be necessary. If this is the case, utilization of hydrologic expertise is essential.

When time constraints or lack of personnel capabilities require the use of this methodology in quantifying flow requirements, certain limitations must be recognized. It is an office procedure only. It is limited in that it depends entirely on the mean annual flow. Used thusly, it would not take into account the flow fluctuations or seasonal variability. For example, if the stream has high peaks (response to intense storms), a percentage value may be recommended that can seldom be attained. This is expressed in Figure 3.

This method is best suited for large stream systems (less variability), rather than small highly variable streams.

When used as strictly an office technique, the method does not account for the geometry of the stream channel. For example, 60 percent of the mean annual flow might be very shallow in a wide flat channel, not providing sufficient depth for the instream needs, as opposed to a narrow channel where 60 percent of the flow would be more than adequate. This fact is expressed in Figure 4.

Also, the average 10-day and 30-day natural low-flow values should be compared to the Tennant flow characteristics, if such data are available.

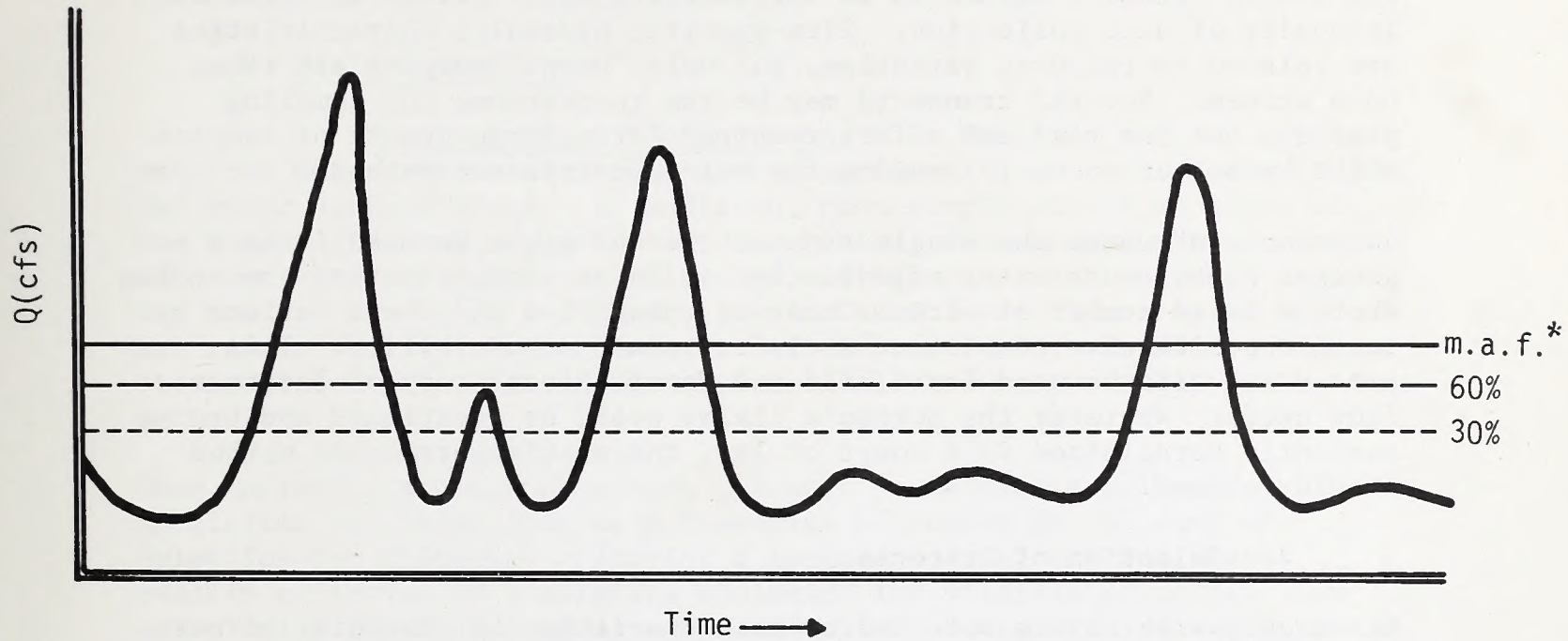


Figure 3. Storm or annual hydrographs showing the variability not accounted for in the reconnaissance method.

\*m.a.f. = mean annual flow

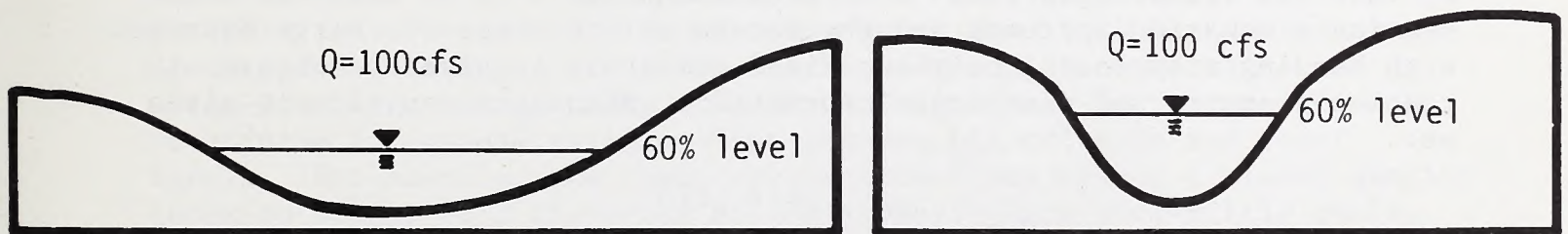


Figure 4. Channel cross-sections showing the variability in channel geometry not accounted for in the reconnaissance method.

## C. Single Transect Method

### 1. Application of the Single Transect Method

The single transect method is an intermediate-level effort in terms of intensity of data collection. Site-specific hydraulic characteristics are related to resource variables, but only "point" samples are taken on a stream. Several transects may be run to overcome the sampling problem, but the time and effort required for a large number of samples might be better spent in running the multiple-transect method.

An example of where the single transect method might be used is in a general State court water adjudication or in an administrative proceeding where a large number of streams must be quantified and where serious legal opposition to the Bureau's claims is not a possibility. This method may also be used for a Wild and Scenic River study of instream flow needs. Wherever the Bureau's claims would be questioned and carefully scrutinized in a court of law, the multiple-transect method should be used.

### 2. Selection of Criteria

Resource variables are selected by each specialist for the disciplines identified in Chapter IV. For the single-transect method, the site is chosen which is critical to the particular resource variable or set of resource variables. In some cases it may be necessary to establish several transects in order to accommodate all the variables that are being considered.

### 3. Hydraulic Determinations

Two approaches are available for determining flow discharges corresponding to selected variable levels. The first technique will be referred to as Manning's equation approach and the second as the stage-discharge approach. With Manning's approach, only one field effort is required to obtain channel geometry and discharge information. Manning's equation is given as:

$$Q = \frac{1.486 A S^{1/2} R^{2/3}}{n}$$

where Q is discharge, A the cross sectional channel area, S the slope of the water surface, R the hydraulic radius, and n the roughness coefficient.

By using Manning's equation, other discharges and their corresponding hydraulic parameters may be calculated with the use of a computer or desktop calculator.

With the stage-discharge approach, several field measurements at different flow levels are required. At several different flow levels, observations

of resource variables are made including for example: depth, velocity, width, wetted perimeter, pool-riffle ratio, visual quality index, etc. These data are functionally related to stage readings taken at the same time. Then through the stage-discharge relationships, discharge values can be determined.

#### 4. Field Procedures

a. Manning's Equation Approach. The Manning equation approach requires measurements of channel cross sectional geometry, discharge (Q), and water surface slope. In addition, photographs should be taken of the channel reaches measured. It is critical that accurate measurements of Q and slope be made. A calibrated current meter and engineer's level and rod are essential equipment items. One or more transects as needed are run to satisfy the requirements of each variable. However, these transects are not tied together hydraulically as in the multiple-transect method.

This approach requires that each transect be carefully selected by the specialist involved, such as a fisheries biologist in the case of selection for fisheries criteria; a landscape architect for visual quality criteria; or a wildlife biologist for wildlife criteria. The hydrologist should accompany each specialist during site selection to ensure that the site selection also meets the criteria for good hydraulic measurement. The discharge measurement site can be located at a different point on the channel from where the transect is located, as long as the discharge is the same. An example of this would be a fisheries transect across a riffle with the discharge measurement taken at a nearby hydraulic control point.

b. Stage-discharge Approach. Using the stage-discharge approach, a hydraulic reference station is established by the hydrologist at a suitable site. This station consists of a staff gage, water level recorder, or other means of monitoring water level. Subsequent stage-discharge measurements are taken by the hydrologist to establish a stage-discharge relationship. Each specialist then is responsible for developing functional relationships between his criteria and water levels. For example, the landscape architect may relate a visual quality index to stage, or a fisheries biologist may relate pool-riffle ratio, wetted perimeter, or average passage depth to stage. The hydrologist may wish to correlate water table depth in a critical riparian vegetation stand to stage, or to correlate stream competence in a spawning gravel bed to stage. Through the stage-discharge relationship, all variables may be examined in terms of their relationship to discharge.

The main disadvantage to using the Manning equation approach is that the hydraulic simulation process assumes both  $n$ , the roughness coefficient, and  $S$ , the hydraulic slope, are constant with discharge. This assumption can lead to serious errors in the extrapolations of various discharges from the measured discharge. The hydrologist must account for the

variation of  $n$  with  $Q$  and slope with  $Q$ , which should be determined in the field for each transect or otherwise explained and accounted for quantitatively.

Although the stage-discharge approach overcomes some of the accuracy problems associated with the use of the Manning equation, it involves much more field time than does the Manning equation approach. The hydrologist must consider both time constraints and accuracy in making a decision between the two procedures.

## 5. Analysis

Each specialist is responsible for developing a table or graph which depicts the behavior of his criteria at various flow levels. This will be done for the Manning equation or the stage-discharge approaches. All the transects or sampling points are analyzed in this manner, each transect being represented by a table or graph. Examples are shown in Table 2 and Figure 5.

A computer program based in part on the U.S. Forest Service Region 2 R2CROSS program has been modified for use on the BLM's Honeywell 66/80 computer. The program, FISHFLO, is currently being rewritten into an interactive mode. It is designed to accept field data from the single-transect, Manning's type approach. A procedure is incorporated that will allow for adjustments in either Manning's  $n$  or the slope. If single-transect data are processed through FISHFLO, there is no need to level the cross section end stakes during field measurements.

## 6. Flow Selection

Flow selection is based upon the individual specialist's analysis of his criteria. The specialist may choose to select an array of desired flows corresponding to different times of the year. A hydrograph of recommended flows is then developed based upon input from all the specialists, as discussed below.

### D. Multiple Transect Method

The "Multiple Transect - Incremental Flow" method is being developed by the multiagency Cooperative Instream Flow Service Group (CIFSG) in Fort Collins, Colorado. It is based on a series of stream transects at representative points in the stream reach(es) used to formulate a mathematical model which predicts hydraulic and physical properties of the stream over a range of discharges. This method is the most scientifically and legally defensible one available for most instream flow problems. Further, it best facilitates assessment of impacts resulting from flow alterations and of management alternatives. However, this method requires the greatest investment of field work and data analysis, although a computer program (HABITAT) is available to greatly assist with data analysis. Preselection of data points is less critical than with the single transect method, thereby requiring less professional input but more field technician time.

TABLE 2

Tabulation of Discharge and Other Stream Variables from a Single-  
Transect Sample, Stuck Creek, Larimer County, Colorado

Discharge (cfs)	Max. Depth (feet)	Wetted Perimeter (feet)	Hydraulic Radius (feet)	Avg. Velocity (ft/sec)
14.28	1.3	15.4	.810	1.147
9.47	1.1	15.0	.643	.984
5.64	.9	12.1	.535	.870
3.02	.7	11.7	.376	.688
.80	.4	7.1	.228	.493
.36	.3	5.3	.169	.403
.13	.2	5.1	.093	.271

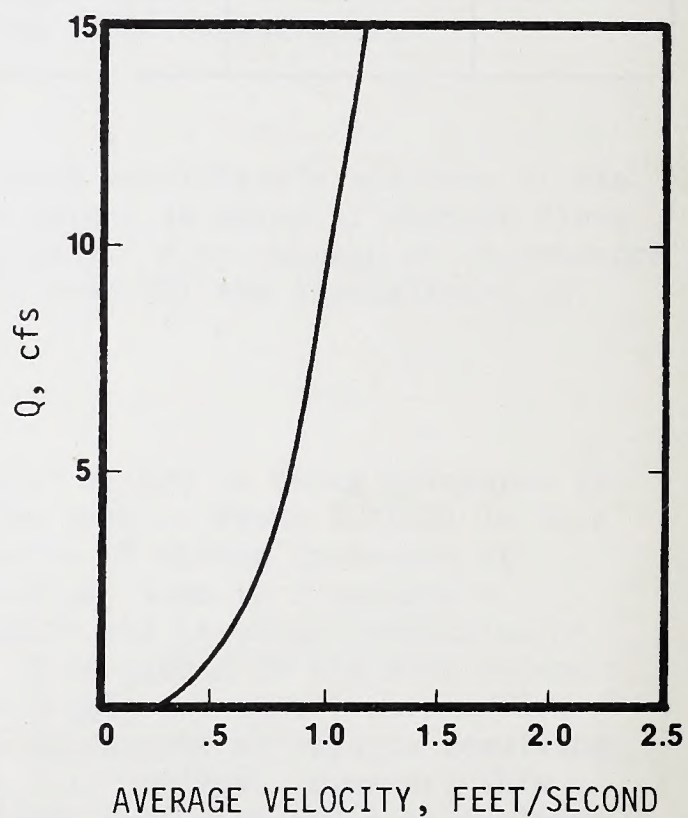
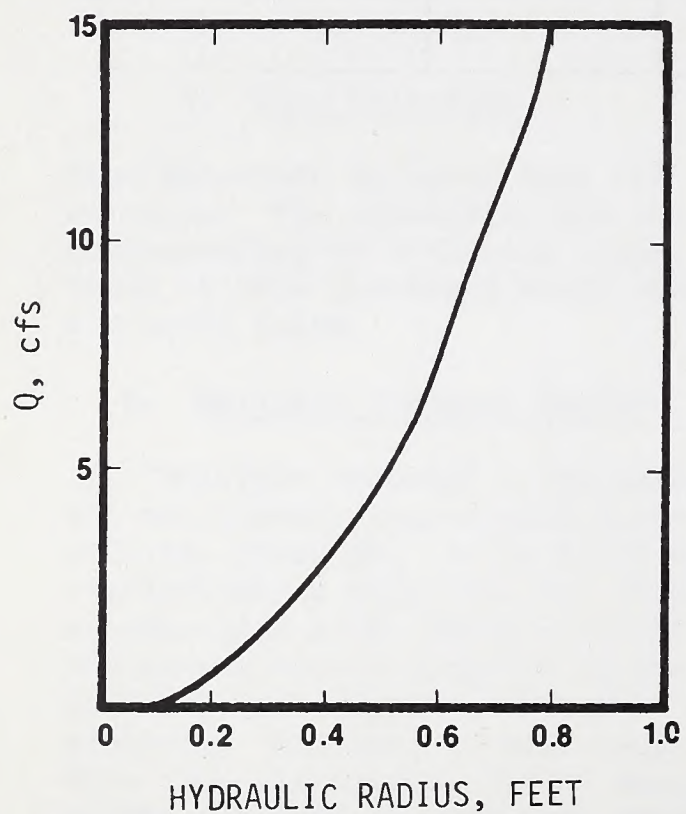
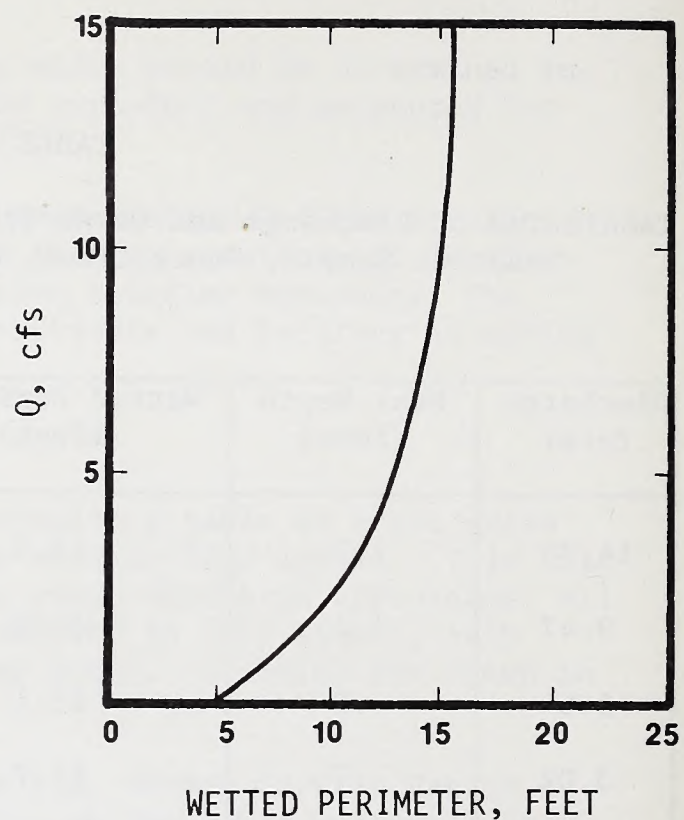
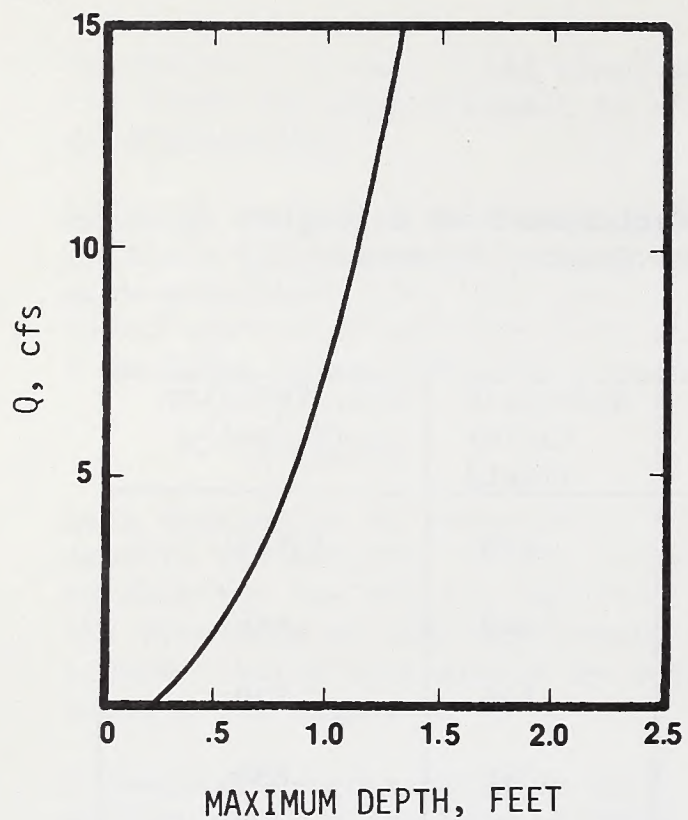


Figure 5. Graphs relating discharge,  $Q$ , to four stream channel characteristics. Based on Table 2.

## 1. Application of the Method

This method is recommended for situations that might involve legal or political challenge or where management wishes to examine a range of management options to achieve the best mix of values gained or lost. It produces an informational array which can be interpreted for a number of resource criteria.

## 2. Description of the Method

The Multiple Transect-Incremental Flow method was developed to assess the effects of variations in streamflow regimen on fish at their various life stages. However, the hydraulic simulation feature permits other resource interpretations. The method is described as being composed of three components (Bovee, 1977). Bovee and Milhous (1978) have provided the detailed information for field application.

a. Hydraulic Simulation. The stream reach to be studied is first divided into homogeneous subreaches as described in Chapter I(B). Locations for transects are then randomly selected on the working map, about six per subreach. The team will review these locations in the field, retaining only those locations that are significantly different hydraulically and in habitat type.

Several level and rod cross sectional transects are then run at each location, using the single cross section procedure described earlier. However, each cross section is tied to the next by horizontal distance and elevation. Substrate sampling, flow velocity, water surface elevation, and depth measurements are taken at each cross section. This procedure is repeated at three widely varied stages of flow. A field crew of three has proved ideal, completing an average of two sets of multiple cross sections per day (10 per week) (Prewitt and Carlson, 1977). Needed field equipment includes:

- (1) self-leveling engineer's level,
- (2) level rod,
- (3) survey stakes,
- (4) tape (steel or fiberglass), and
- (5) stream gaging equipment (current meter, wading rod, etc.).

Variations on this list will be needed for larger rivers where use of a boat or cableway are necessary. It should be emphasized that channel cross section and water surface slopes must be measured accurately with an engineer's level.

The data analysis is accomplished by use of a computer software package entitled "HABITAT" or "IFG-4" being developed by the CIFSG (Bovee, 1977). The computer divides the cross sectional transects into 9 to 20 subsections, each described in terms of hydraulic parameters, substrate, and other physical features noted in the field data. It then extends each subsection half the distance to the next section (see Figure 6). This amounts to a hydraulic model for that subreach location. The model is based upon the stage-discharge relationship up to the highest stage included in the field measurements, extended beyond that using Manning's equation. The model relates discharge to mean depth and velocity, surface width, and wetted perimeter.

The computer output from this hydraulic simulation is a multi-dimensional matrix showing the water surface area having various combinations of parameters (i.e., depth, velocity, and substrate) at a user selected discharge. See Table 3. As an example, the table shows that at depths less than 1.0 foot and velocities less than 0.5 ft. per second, there are 195 square feet per 100 feet of stream. Of interest to the biologist is how that area varies with discharge. Then, in order to evaluate the impacts resulting from these changes in stream hydraulics, it is necessary to adopt certain critical or limiting research criteria (see Chapter IV). Fishery criteria are primarily those relating to their distribution in the water, such as those criteria which are unique for each life stage of each species.

The incremental method employs what is termed "probability criteria." Again, for the fishery example, Bovee assumes that, "the distribution and abundance of any species is not primarily influenced by any single parameter of streamflow, but related by varying degrees to all streamflow parameters. Furthermore, these criteria are based on the assumption that individuals of a species will tend to select the most favorable conditions in a stream, but will also use less favorable conditions, with the probability of use decreasing as conditions become less favorable" (Bovee, 1977). Likewise, there is a range of conditions that are most favorable for certain recreational uses, with the probability of use decreasing as that range is exceeded.

b. Composite Probability of Use. The CIFSG has developed a series of "probability of use curves" for various fish species and their life stages, and for recreational uses (Bovee, 1978; Hyra, 1978). The curves have been incorporated into a curve maintenance program, which is part of the "HABITAT" software package. These curves are a plot of use probability as a function of each parameter. Sample curves are shown in Figure 7. A "composite use probability" is then obtained by multiplying the use probabilities for each parameter together. For example, the composite use probability for adult smallmouth bass at a depth of 3.5 feet and velocity of 0.5 ft. per second is  $0.37 \times 0.81 = 0.30$ .

Figure 6. Computer conceptualization of simulated stream reach. Hydraulic parameters of depth, velocity, and substrate for each major transect subdivision are assigned to the area of subdivision block.

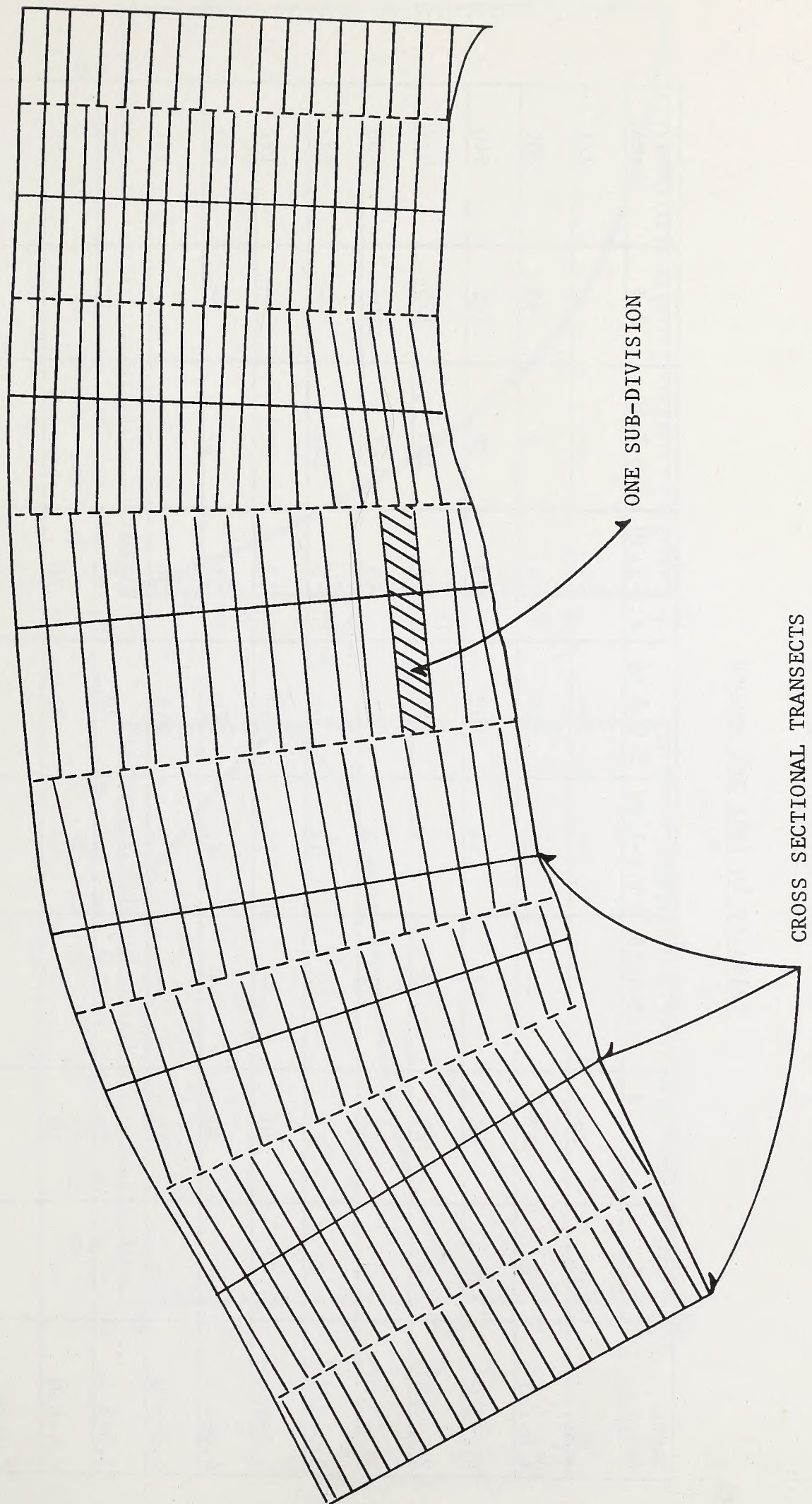


TABLE 3

Distribution of Combinations of Depth and Velocity<sup>1/</sup>Velocity in feet per second

Depth (ft.)	.5	.5-.99	1.0-1.49	1.5-1.99	2.0-2.49	2.5-2.99	3.0-3.49	3.5	Row Total
1	195	26	--	--	--	--	--	--	221
1.0-1.5	90	47	--	41	17	6	6	93	300
1.5-2.0	29	38	32	44	108	79	38	172	540
2.0-2.5	6	29	23	9	111	131	143	175	627
2.5-3.0	6	15	55	79	41	64	41	105	406
3.0-3.5	9	17	15	12	32	3	149	--	237
3.5-4.0	9	20	--	17	47	17	82	--	192
4.0-4.5	--	20	--	11	50	35	17	--	133
4.5-5.0	--	11	--	5	115	20	--	--	151
5.0-5.5	--	--	--	7	23	15	--	--	45
5.5-6.0	--	10	--	--	31	20	--	--	61
Column Total	344	233	125	225	575	390	476	545	2913

<sup>1/</sup> Expressed in square feet of surface area per 100 ft of stream, at 800 cfs discharge (Bovee, 1977).

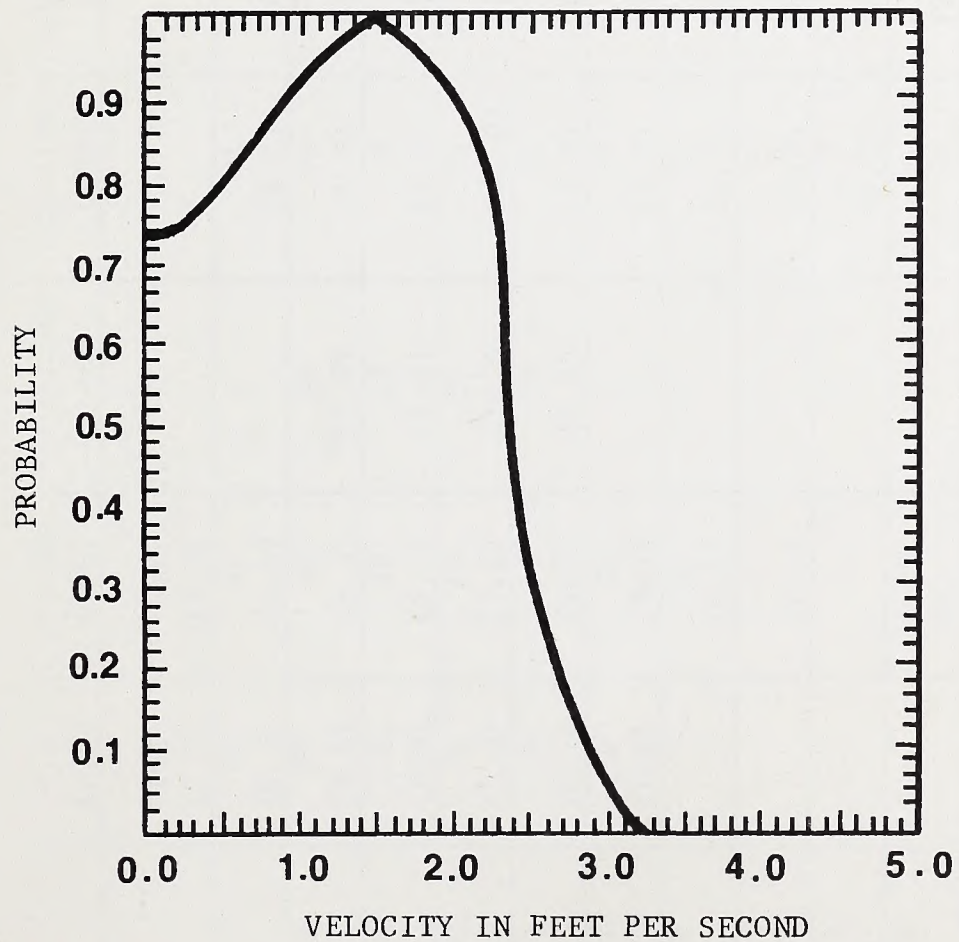
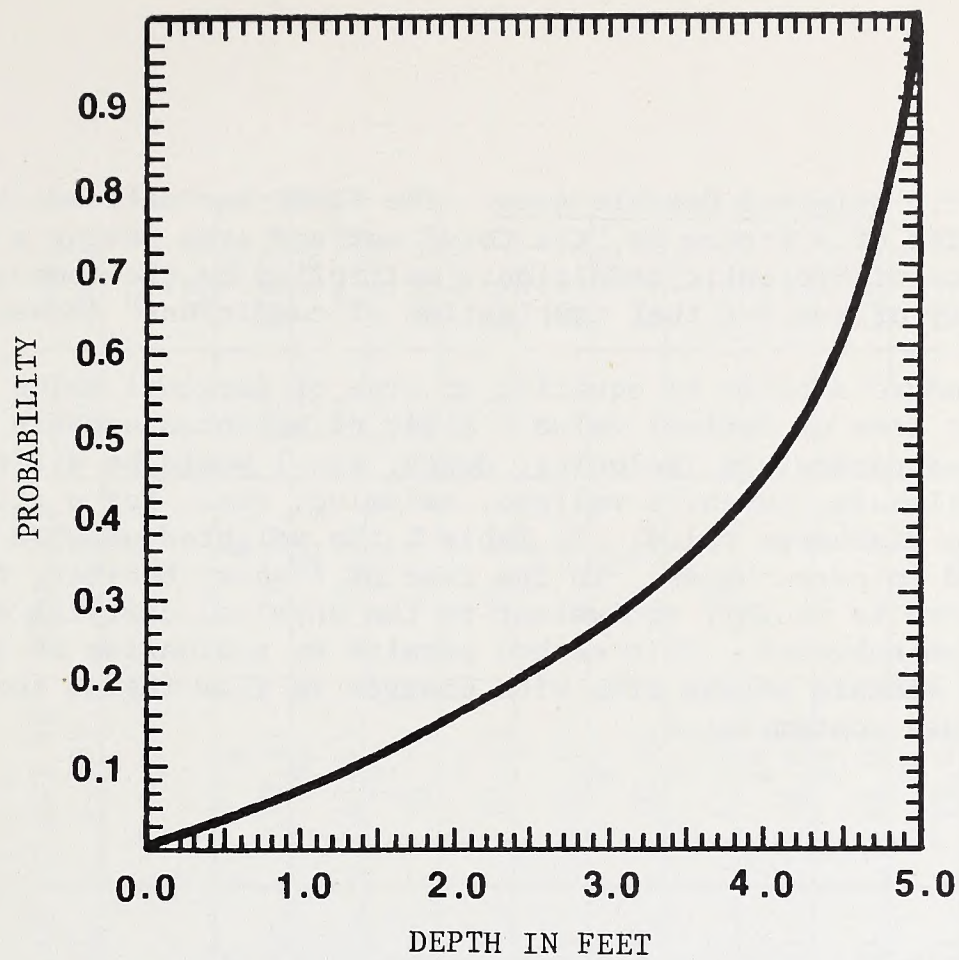


Figure 7. Probability of use curves for adult smallmouth bass (from Bovee, 1977).

c. Weighted Useable Area. The CIFSG has defined the weighted useable area of a stream as "the total surface area having a certain combination of hydraulic conditions, multiplied by the composite probability of use for that combination of conditions" (Bovee, 1977).

This procedure amounts to equating an area of marginal value to an equivalent area of optimal value. A set of weighted useable areas based on selected parameters (velocity, depth, etc.) would be different for adult smallmouth, juvenile walleye, swimming, etc., for a given reach at a given discharge value. In Table 4 the weighted useable areas have been added in parentheses. In the case of fishery habitat, the weighted useable area is roughly equivalent to the physical carrying capacity of that stream subreach. This method permits an evaluation of the variability of useable stream area with changes in flow regime for each resource use contemplated.

TABLE 4

Calculation of Weighted Useable Area for Adult Smallmouth Bass<sup>1/</sup>

Velocity in feet per second										Row
Depth (ft.)	<.5 (.75)	.5-.99 (.90)	1.0-1.49 (.98)	1.5-1.99 (.98)	2.0-2.49 (.73)	2.5-2.99 (.13)	3.0-3.49 (.03)	>3.5 (0)	Total	
<1 (.05)	195 (7.3)	26 (1.2)	-	-	-	-	-	-	221 (8.5)	
1.0-1.5 (.12)	90 (8.1)	47 (5.1)	-	41 (4.8)	17 (1.5)	6 (0.1)	6 (0.0)	93 (0)	300 (19.6)	
1.5-2.0 (.16)	29 (3.5)	38 (5.5)	32 (5.0)	44 (6.9)	108 (12.6)	79 (1.6)	38 (0.2)	172 (0)	540 (35.3)	
2.0-2.5 (.22)	6 (1.0)	29 (5.7)	23 (5.0)	9 (1.9)	111 (17.8)	131 (3.7)	143 (0.9)	175 (0)	627 (36.0)	
2.5-3.0 (.27)	6 (1.2)	15 (3.6)	55 (14.5)	79 (20.0)	41 (8.1)	64 (2.2)	41 (0.3)	105 (0)	406 (50.3)	
3.0-3.5 (.33)	9 (2.2)	17 (5.0)	15 (4.9)	12 (3.9)	32 (7.7)	3 (0.1)	149 (.15)	-	237 (25.3)	
3.5-4.0 (.42)	9 (1.6)	20 (7.6)	-	17 (7.0)	47 (14.4)	17 (0.9)	82 (1.0)	-	192 (32.5)	
4.0-4.5 (.53)	-	20 (9.5)	-	11 (5.7)	50 (19.3)	35 (2.4)	17 (0.3)	-	133 (37.2)	
4.5-5.0 (.75)	-	11 (7.4)	-	5 (3.7)	115 (63.0)	20 (2.0)	-	-	151 (76.1)	
5.0-5.5 (1.0)	-	-	-	7 (6.9)	23 (16.8)	15 (2.0)	-	-	45 (25.7)	
5.5-6.0 (1.0)	-	10 (9)	-	-	31 (22.6)	20 (2.6)	-	-	61 (34.3)	
Column Total	344 (24.9)	233 (59.6)	125 (29.4)	225 (61.7)	575 (183.8)	390 (17.6)	476 (4.2)	545 (0)	2913 (381)	

<sup>1/</sup> From Table 3. Discharge = 800 cfs (Bovee, 1977).



## CHAPTER VI. - DEVELOPMENT OF INSTREAM FLOW RECOMMENDATIONS

Application of the above quantification methods will result in a range of possible flows, which might represent conflicting needs among resource values and which will show seasonal variations in flow needs. If more than one resource use is being evaluated, the team should present to management a set of alternatives from which to choose. All of these alternatives should meet the following tests:

- (1) Must be reasonable in light of other international, national, regional, and local needs and concerns (as applicable),
- (2) Must recognize prior rights (keeping in mind that a State administrative allocation does not necessarily require recognition by the Federal Government except when it is established as a legal right in a court adjudication),
- (3) Must be quantified by season and referenced to a specific point(s) of measurement,
- (4) Must meet Federal-State water quality standards, and
- (5) The resource criteria upon which the flow recommendations are based must be reasonable and supported either by good professional judgment or by past precedent, such as in the technical literature (see Chapter IV, F).

Each alternative flow regime must be described in terms of:

- (1) What resource values are lost or gained?
  - (2) How well can it be satisfied by natural availability of flow (i.e., continuously, 9 in 10 years, etc.)? See Chapter V(A), Analysis of Hydrologic Records,
  - (3) To what extent will that level of instream reservation affect other uses (irrigation, minerals, etc.)?
  - (4) How well does the alternative compliment multiple uses?
  - (5) What are the pros and cons that can guide management?
- Some of this information can be depicted by superimposing it on the streamflow hydrograph.

The final team effort will be to prepare a "schedule of flows" or monthly streamflow hydrograph based on the manager's decision. This schedule would show the monthly discharge to which the BLM makes claim for support of the identified resource program needs. All documents, maps, and data resulting from this effort should be retained in a permanent file in case the claim becomes subject to legal challenge or managerial re-evaluation.



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## Appendix 1

### STATUTORY AUTHORITY

1. Taylor Grazing Act, Act of June 28, 1934, as amended (43 U.S.C. 315, as amended):

In order to promote the highest use of the public lands . . . , the Secretary of the Interior is authorized, in his discretion by order to establish grazing districts . . . of vacant, unappropriated, and unreserved lands from any part of the public domain of the United States (exclusive of Alaska) . . . and which in his opinion are chiefly valuable for grazing and raising forage crops . . . .  
[Also authorizes inclusion of reserved lands with approval of department having jurisdiction.]

Sec. 315(a). The Secretary of the Interior shall make provision for the protection, administration, regulation, and improvement of such grazing districts as may be created under the authority of Section 315 of this title, and he shall make such rules and regulations and establish such service, enter into such cooperative agreements, and do any and all things necessary to accomplish the purposes of this subchapter and to insure the objects of such grazing districts, namely, to regulate their occupancy and use, to preserve the land and its resources from destruction or unnecessary injury, to provide for the orderly use, improvement, and development of the range; and the Secretary of the Interior is authorized to continue the study of erosion and flood control and to perform such work as may be necessary amply to protect and rehabilitate the areas subject to the provisions of this subchapter . . . (emphasis added).

Sec. 315(b). . . . nothing in this subchapter shall be construed or administered in any way to diminish or impair any right to the possession and use of water for mining, agriculture, manufacturing, or other purposes which has heretofore vested or accrued under existing law validity affecting the public lands or which may be hereafter initiated or acquired and maintained in accordance with such law . . . .

Sec. 315(h). The Secretary of the Interior shall provide, by suitable rules and regulations, for cooperation with local associations of stockmen, State land officials, and official State agencies engaged in conservation or propagation of wildlife interested in the use of the grazing districts . . . .

2. Act of August 28, 1937 (O & C Act) (50 Stat. 874; 43 U.S.C. 1181):

Sec. 1181(a). . . . such portions of the revested Oregon and California Railroad and reconveyed Coos Bay Wagon Road grant lands as are or may hereafter come under the jurisdiction of the Department of the Interior,

which have heretofore or may hereafter be classified as timberlands, and power-site lands valuable for timber, shall be managed, except [for those lands classified as more suitable for agricultural use], for permanent forest production, . . . protecting watersheds, regulating stream flow, . . . and providing recreational facilities . . . (emphasis added).

Sec. 1181(b). The Secretary of the Interior is authorized, in his discretion, to make cooperative agreements with other Federal or State Forest administrative agencies or with private forest owners or operators for the coordinated administration, . . . when by such agreements he may be aided in accomplishing the purposes mentioned . . .

Sec. 1181(c). [Authorizes classification of lands for agricultural use if "more suitable for agricultural use than for afforestation, reforestation, stream flow protection, recreation, or other public purposes" (emphasis added).] [This section aids in the interpretation of Section 1181(a).]

Sec. 1181(e). The Secretary of the Interior is authorized to perform any and all acts and to make such rules and regulations as may be necessary and proper for the purpose of carrying the provisions of Sections 1181(a) to 1181(f) of this title into full force and effect . . . [Also authorizes the formulation of regulations for the protection of the O & C timber lands against fire. Fire protection may require adequate stream flows.]

3. Act of March 29, 1944 (58 Stat. 132; 16 U.S.C. 583):

Sec. 583. . . . in order to provide for a continuous and ample supply of forest products; and in order to secure the benefits of forests in maintenance of water supply, regulation of stream flow, prevention of soil erosion, amelioration of climate, and preservation of wildlife, the Secretary of Agriculture and the Secretary of the Interior are severally authorized to establish by formal declaration, when in their respective judgements such action would be in the public interest, cooperative sustained-yield units which shall consist of Federally owned or administered forest land under the jurisdiction of the Secretary establishing the unit and, in addition thereto, land which reasonably may be expected to be made the subject of one or more of the cooperative agreements with private landowners authorized by Section 583(a) of this title (emphasis added).

[Section 583(c) authorizes cooperative agreements among various agencies of the Federal Government.]

4. Wilderness Act, Act of September 3, 1964 (78 Stat. 891), as amended (16 U.S.C. 1131), as referenced by Section 603 of the Federal Land Policy and Management Act of 1976, cited below:

5. Act of September 19, 1964 (Classification and Multiple-Use Act; P.L. 88-607; 78 Stat. 986):

Sec. 1. . . . consistent with and supplemental to the Taylor Grazing Act . . . and pending the implementation of recommendations to be made by the Public Land Law Review Commission . . .

(a) The Secretary of the Interior shall develop and promulgate regulations containing criteria by which he will determine which of the public lands . . . shall be (a) disposed of . . . or (b) retained, at least during this period, in Federal ownership and management for (1) domestic livestock grazing, (2) fish and wildlife development and utilization, (3) industrial development, (4) mineral production, (5) occupancy, (6) outdoor recreation, (7) timber production, (8) watershed protection, (9) wilderness preservation, or (10) preservation of public values that would be lost if the land passed from Federal ownership . . . (emphasis added).

(b) . . . In making his determinations the Secretary shall give due consideration to all pertinent factors, including, but not limited to, ecology, priorities of use, and the relative values of the various resources in particular areas.

Sec. 3. The Secretary of the Interior shall develop and administer for multiple use and sustained yield of the several products and services obtainable there from those public lands that are determined to be suitable for interim management in accordance with regulations promulgated pursuant to this Act.

6. Rare and Endangered Species Act of 1966 (80 Stat. 926 - 930) as amended by the Endangered Species Act of 1969 and substantially replaced by the Endangered Species Act of 1973 (now 16 U.S.C. 1531 - 1543):

Sec. 1531(c). Congressional findings and declarations of purpose and policy. . . . It is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this chapter (emphasis added).

Sec. 1533(d). Protective regulations: Whenever any species is listed as a threatened species pursuant to subsection 1533(c), the Secretary shall issue such regulations as he deems necessary and advisable to provide for the conservation of such species. . .

Sec. 1536. Interagency cooperation. The Secretary shall review other programs administered by him and utilize such programs in furtherance of the purposes of this chapter. All other Federal departments and agencies shall, in consultation with and with the

assistance of the Secretary, utilize their authorities in furtherance of the purposes of this chapter by carrying out programs for the conservation of endangered species and threatened species listed pursuant to Section 1533 of this title and by taking such action necessary to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined by the Secretary, after consultation as appropriate with the affected states, to be critical.

7. Wild and Scenic Rivers Act, Act of October 2, 1968 (82 Stat. 906), as amended (16 U.S.C. 1271):

Sec. 1271. It is hereby declared to be the policy of the United States that certain selected rivers of the Nation which, with their immediate environments, possess outstanding remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, shall be preserved in free-flowing condition . . . (emphasis added).

A. Utilize a systematic, interdisciplinary approach which will ensure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision making which may have an impact on man's environment;

B. Identify and develop methods and procedures . . . which will ensure that presently quantified environmental amenities and values may be given appropriate consideration in decisionmaking . . . (emphasis added).

G. Initiate and utilize ecological information in the planning and development of resource-oriented projects . . .

8. Act of October 18, 1974 (Sikes Act; P.L. 93-452; 88 Stat. 1369; 43 U.S.C. 670):

#### Subchapter II - Conservation Programs on Public Lands

Sec. 670(g). (a) The Secretary of the Interior and the Secretary of Agriculture shall each, in cooperation with the State agencies and in accordance with comprehensive plans developed pursuant to Section 670(h) of this title, plan, develop, maintain, and coordinate programs for the conservation and rehabilitation of wildlife, fish and game. Such conservation and rehabilitation programs shall include, but not be limited to, specific habitat improvement projects and related activities and adequate protection for species considered threatened or endangered (emphasis added).

(b) The Secretary of the Interior shall implement the conservation and rehabilitation programs required under subsection (a) of this section on public lands under his jurisdiction . . .

Sec. 670(h). (a)(1) The Secretary of the Interior shall develop, in consultation with the State agencies, a comprehensive plan for conservation and rehabilitation programs to be implemented on public land under his jurisdiction . . . (emphasis added).

(2) . . . Each such plan shall be developed after the Secretary of the Interior makes . . . in consultation with the State agencies, necessary studies and surveys of the land concerned to determine where conservation and rehabilitation programs are most needed.

(c)(1) Each State agency may enter into a cooperative agreement with:

A. The Secretary of the Interior with respect to those conservation and rehabilitation programs to be implemented under this subchapter within the State on public land which is under his jurisdiction;

Conservation and rehabilitation programs developed and implemented pursuant to this subchapter shall be deemed as supplemental to wildlife, fish, and game-related programs conducted by the Secretary of the Interior and the Secretary of Agriculture pursuant to other provisions of law. . . .

[See paragraph (c)(3) of this section for the requirements for cooperative agreements under this authority.]

9. Federal Land Policy and Management Act of 1976, Act of October 21, 1976 (P.L. 94-579; 90 Stat. 2743):

Sec. 102(a) The Congress declares that it is the policy of the United States that:

(2) The national interest will be best realized if the public lands and their resources are periodically and systematically inventoried and their present and future use is projected through a land use planning process coordinated with other Federal and State planning efforts;

(8) The public lands be managed in a manner that will protect the quality of scientific, scenic, historical, ecological, environmental, and archeological values; that, where appropriate, will preserve and protect certain public lands in their natural condition; that will provide food and habitat for fish and wildlife

and domestic animals; and that will provide for outdoor recreation and human occupancy and use (emphasis added);

(b) The policies of this Act . . . shall be construed as supplemental to and not in derogation of the purposes for which public lands are administered under other provisions of law.

Sec. 103(e). The term "public lands" means any land and interest in land owned by the United States within the several States and administered by the Secretary of the Interior through the Bureau of Land Management.

Sec. 201(a). The Secretary shall prepare and maintain on a continuing basis an inventory of all public lands and their resource and other values (including, but not limited to, outdoor recreation and scenic values), giving priority to areas of critical environmental concern . . . (emphasis added).

Sec. 204(a). On and after the effective date of this Act the Secretary is authorized to make, modify, extend, or revoke withdrawals but only in accordance with the provisions and limitations of this section . . . [Section 204 repeals all preexisting executive withdrawal authority and enacts a comprehensive procedure for establishing future withdrawals by Act of Congress. Provision is made for emergency withdrawals and withdrawals in aid of legislation. Under authority of paragraph (1)(1), all withdrawals from the public domain in the States of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington,\* and Wyoming shall be reviewed within 15 years.]

Sec. 302(a). The Secretary shall manage the public lands under principles of multiple use and sustained yield, in accordance with the land use plans developed by him . . .

Sec. 307(b). . . . the Secretary may enter into contracts and cooperative agreements involving the management, protection, development, and sale of public lands. . . .

Sec. 310. The Secretary, with respect to the public lands, shall promulgate rules and regulations to carry out the purposes of this Act and of other laws applicable to the public lands . . .

Sec. 603(a). Within fifteen years after the date of approval of this Act, the Secretary shall review those roadless areas of five thousand acres or more and roadless islands of the public lands, identified during the inventory required by Section 201(a) of this Act as having wilderness characteristics described in the Wilderness Act of September 3, 1964 (78 Stat. 890; 16 U.S.C. 1131 et seq.) and shall from time to time report to the President his recommendation as to the suitability or unsuitability of each such area or island for preservation as wilderness . . .

(b) . . . A recommendation of the President for designation as wilderness shall become effective only if so provided by an Act of Congress.

(c) During the period of review of such areas and until Congress has determined otherwise, the Secretary shall continue to manage such lands according to his authority under this Act and other applicable law in a manner so as not to impair the suitability of such areas for preservation as wilderness . . . Provided, that, in managing the public lands the Secretary shall by regulation or otherwise take any action required to prevent unnecessary or undue degradation of the lands and their resources or to afford environmental protection. . . . Once an area has been designated for reservation as wilderness, the provisions of the Wilderness Act which apply to national forest wilderness areas shall apply with respect to the administration and use of such designated area . . . (emphasis added).

10. Fish and Wildlife Coordination Act, Act of March 10, 1934, as amended (43 U.S.C. 661-666c):

Sec. 661. [This authority applies only to lands included within water resource construction and improvement projects as defined by the Act. Generally speaking, the Fish and Wildlife Service is the implementing agency.]

. . . the Secretary of the Interior is authorized (1) to provide assistance to, and cooperate with, Federal, State, and public or private agencies and organizations in the development, protection, rearing, and stocking of all species of wildlife, resources thereof, and their habitat, in controlling losses of the same from disease or other causes, in minimizing damages from over abundant species, . . . and in carrying out other measures necessary to effect the purposes of [16 U.S.C. 661 to 666]; (2) to make surveys and investigations of the wildlife of the public domain, including lands and waters or interests therein acquired or controlled by any agency of the United States; . . .

Sec. 664. Such areas as are made available to the Secretary of the Interior for the purposes of Section 661 to 666c of this title . . . shall be administered by him directly or in accordance with cooperative agreements entered into pursuant to the provisions of Section 661 of this title and in accordance with such rules and regulations for the conservation, maintenance, and management of wildlife, resources thereof, and its habitat thereon, as may be adapted by the Secretary in accordance with general plans approved jointly by the Secretary of the Interior and the head of the department or agency exercising primary administration of such areas.

Sec. 666(b). The terms "wildlife" and "wildlife resources" as used in Sections 661 to 666(c) of this title includes birds, fishes, mammals, and all other classes of wild animals and all types of aquatic and land vegetation upon which wildlife is dependent.

11. Watershed Protection and Flood Prevention Act, Act of August 4, 1954 (68 Stat. 666), as amended (16 U.S.C. 1001):

Sec. 1006. The Secretary [of Agriculture] is authorized in cooperation with other Federal and with States and local agencies to make investigations and surveys of the watersheds of rivers and other waterways as a basis for the development of coordinated programs. In areas where the programs of the Secretary of Agriculture may affect public or other lands under the jurisdiction of the Secretary of the Interior, the Secretary of the Interior is authorized to cooperate with the Secretary of Agriculture in the planning and development of works or programs for such lands.

[This Act is the empowering statute for the Soil and Water Conservation Service of the Department of Agriculture. Some wildlife habitat maintenance programs might possibly benefit from jointly initiated watershed protection efforts.]

12. Water Resources Planning Act, Act of July 22, 1965 (79 Stat. 244; 42 U.S.C. 1962, et seq.):

Sec. 1962(b)-4. (d) Upon request of the chairman of any river basin commission, or any member or employee of such commission designated by the chairman thereof for the purpose, the head of any Federal department or agency is authorized (1) to furnish to such commission such information as may be necessary for carrying out its functions and as may be available to or procurable by such department or agency . . . (emphasis added).

13. Water Bank Act, Act of December 19, 1970 (84 Stat. 1468; 43 U.S.C. 1301, et seq.):

Sec. 1301. The Congress finds that it is in the public interest to preserve, restore, and improve the wetlands of the Nation, and thereby to conserve surface waters, to preserve and improve habitat for migratory waterfowl and other wildlife resources, to reduce runoff, soil and wind erosion, and contribute to flood control, to contribute to improved water quality and reduce stream sedimentation, to contribute to improved subsurface moisture, . . . to enhance the natural beauty of the landscape, and to promote comprehensive and total water management planning. The Secretary of Agriculture . . . is authorized and directed to formulate and carry out a continuous program to prevent the serious loss of wetlands, and to preserve, restore, and improve such lands . . .

[The basic scheme of this statute is the creation of a wetlands conservation bank through payments to private operators and owners working in cooperation with their local Soil and Water Conservation Districts. Claims by the Federal land management agencies for instream flows may be required in order to properly supply and maintain certain wetlands included in the national water bank program.]

Sec. 1309. The Secretary [of Agriculture] shall consult with the Secretary of the Interior and take appropriate measures to ensure that the program carried out pursuant to this chapter is in harmony with wetlands programs administered by the Secretary of the Interior. . . .

14. Coastal Zone Management Act of 1972, Act of October 27, 1972 (86 Stat. 1280; 16 U.S.C. 1451-1464):

Sec. 1452. The Congress finds and declares that it is the national policy (a) to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations . . . (c) for all Federal agencies engaged in programs affecting the coastal zone to cooperate and participate with State and local governments and regional agencies in effectuating the purposes of this chapter, and (d) to encourage the participation of the public, of Federal, State, and local governments and of regional agencies in the development of coastal zone management programs . . . (emphasis added).

Sec. 1456(b). The Secretary [of Commerce] shall not approve the management program submitted by a State pursuant to Section 1455 of this title unless the views of Federal agencies principally affected by such program have been adequately considered. . . .

(c)(1) Each Federal agency conducting or supporting activities directly affecting the coastal zone shall conduct or support those activities in a manner which is, to the maximum extent practicable, consistent with approved State management programs. (Emphasis added.)

15. Safe Drinking Water Act, Act of December 16, 1974 (88 Stat. 1660; 42 U.S.C. 300f, et seq.)

[This statute directs the Administrator of the Environmental Protection Agency to promulgate regulations for the protection of drinking water supplies. The States' government agencies are to be the primary enforcement authorities. The Federal land managing agencies are subject to the regulations to the extent that they apply to watersheds and underground aquifers needed or used for drinking water supply. Campground and recreational site water supply systems are also subject to these regulations.]

16. Federal Water Pollution Control Act Amendments of 1972, Act of October 18, 1972 (P.L. 92-500; 86 Stat. 816) as amended by the Clean Water Act of 1977 (P.L. 95-217; 91 Stat. 1566), see generally 33 U.S.C., Chapter 23:

[Section 208 directs that the Administrator of the Environmental Protection Agency shall promulgate comprehensive regulations intended to control water pollution sources, including nonpoint sources. Under the regulations which have been promulgated, the use of permits is required for any continuing pollution sources. The Federal land management practices are designed to prevent degradation of streams on the lands under their jurisdiction.]

[Section 404 authorizes the Army Corps of Engineers to issue permits for activities which will result in earth disturbances contributing to stream sedimentation or which will result in decreased stream flows because of water impoundment.]

# Appendix 2

## Summary of Existing Uses and Needs by Month

Stream Name: \_\_\_\_\_ Subreach: \_\_\_\_\_

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average Monthly Discharge (cfs) 1/												
Existing Uses (cfs)												
1.												
2.												
3.												
4.												
5.												
6.												
Instream Needs 2/												
1.												
2.												
3.												
4.												

GPO 853-427

- 1/ From flow records if available.  
 2/ Add quantities when determined.









